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 INDEX.

	Page		Page
Alkin's (Lucy) Memoirs of Court of Charles I.	11	Lamarck's Conchology Illustrated, by Crouch ..	11
— Do. of Queen Elizabeth	11	— Epitome of do. by Dubois	11
— Do. of James I.	11	Lardner's Cabinet Cyclopædia	2
— (Dr.) Annals of the Reign of George III.	11	Legends of the Library at Lilies	5
— Select British Poets, from Jonson		L. E. L.'s Poetical Works	8
to Beattie	15	Life, &c. of John Marston Hall	1
Annual Biography and Obituary	10	Lindley's Botanical Works	7
— Retrospect for 1831	10	Loudon's Gardening, Botanical, Agricultural,	
Anster's Faust	4	and Architectural Works	6
Arnot's Elements of Physics	9	McCulloch's Commercial Dictionary	2
Auldjo's Journal of a Visit to Constantinople ..	1	Mackintosh's Reign of James II.	3
Bakewell's Geology	14	Malte Brun's Geography	15
— Philosophical Conversations	5	Mantell's Geology of Sussex	7
Bayldon on Rents and Rates	14	Mary of Burgundy	1
Bloomfield's Greek Testament	6	Mawe's Conchological Works	12
— Thucydides	6	Mephistophiles in England	1
Boase's Primary Geology	3	Montgomery's Lectures	4
Bowdler's Family Shakspeare	11	— Poetical Works	14
— Gibbon's Roman Empire	11	Moore's Poetical Works, &c.	10
Brady's Plain Instructions to Executors	5	Moral of Flowers	3
Britton's Architectural Works	13	Murray's Encyclopædia of Geography	3
— Dictionary of Architect. & Archæology ..	13	Paley's Works	13
Burder's Oriental Customs	14	Parke's Domestic Duties	13
Burns's Christian Philosophy	9	Parnell on Roads	4
Butler's Ancient and Modern Geography	12	Phillips on Painting	4
— Atlases, Ancient and Modern	12	— (John) Guide to Geology	9
— Outline Maps	12	Picture of London (Britton's)	8
— Praxis on Latin Prepositions, and Key ..	12	Reece's Medical Guide	6
Cockburn's Account of the Corporations of Eng-		Rosabel, &c. by Mrs. A. T. Thomson	1
land and Wales	1	Sandford's Lives of Lady Jane Grey and Mrs.	
Colton's Lacon	14	Col. Hutchinson	12
Conversations on Botany	14	— on Woman	12
— Chemistry	15	Scrope's Political Economy	5
— Natural Philosophy	15	Seaward's Narrative	5
— Political Economy	15	Sherer's Life of Wellington	10
— Vegetable Physiology	15	Short Whist, by Major A*****	2
Coxe's Biographical and Historical Works	14	Slaney's British Birds	5
Crotch on Musical Composition	12	Smith's (Sir J. E.) Botanical Works	8
— Lectures on Music	12	— Memoirs	5
Dacre, a Novel, edited by Lady Morley	4	Southey's Poetical Works	12
Doctor (The)	3	— Remains of H. K. White	12
Dover's (Lord) Life of Frederick II.	8	— Select British Poets, from Chaucer	
Drewry on Suspension Bridges	7	to Withers	15
Drummond's Letters to a Young Naturalist ..	11	St. John's Egypt and Mohammed Ali	7
— First Steps to Botany	11	Steel's Shipmaster's Assistant	4
Dunlop's Roman Literature; History of Fiction ..	15	Strictures on Napier's History of the Peninsu-	
Edinburgh Gazetteer and Atlas	9	lar War	4
— Review, Index to	4	Sunday Library, edited by Dr. Dibdin	8
— Selections from	4	Tardy's French Pronouncing Dictionary	15
English in India, and other Sketches	1	Trevor's Life and Times of William III.	1
Farey on Steam Engine	9	Turner's History of England	9
Fitton's Geological Sketches of Hastings	8	— Sacred History	14
Ford's Christian Prayers	3	Turton's British Shells	14
Gipsy (The), by Mr. James	1	Ure's Geology	8
Good's Book of Nature	4	Wallace's Life of George IV.	10
Guide to Watering Places	13	Wardlaw's Sermons	8
Hall's Atlas of the World	7	Wiffen's House of Russell	13
— Index to Do.	7	— Jerusalem Delivered of Tasso	13
Hansard's Fishing in Wales	3	Wilson's (W. Rae) Route through France and	
Hawker's Instructions to Young Sportsmen ..	15	Italy	3
Historical Memoirs of the House of Bourbon ..	10	Withering's British Plants	7
Hooker's Botanical Works	10	Wood on Rail-Roads	10
Hopkins's Political Economy	4	Wordsworth's Poetical Works	10
Hoskins' Travels in Ethiopia	1	— Description of the Lakes	9
Hunt's Architectural Works	5	Wortley's (Lady E. S.) Knight and the En-	
Keith's Mathematical Works, &c.	11	chantress, &c.	9
Kirby and Spence's Entomology	9		





A KEY



TO

STRUCTURAL, PHYSIOLOGICAL, AND SYSTEMATIC

BOTANY,

FOR THE USE OF CLASSES.

BY

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PROFESSOR OF BOTANY IN THE UNIVERSITY OF LONDON, AND IN THE
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588.

Verum quod alias dixi illud hic repeto et inculco, non sperandam à me Methodum undequaque perfectam et omnibus suis numeris absolutam, quæ et plantas in genera ità distribuat ut universæ species comprehendantur, nullâ adhuc anomalâ et sui generis reliquâ, et unumquodque genus notis suis propriis et characteristicis ità circumscribat, ut nullæ inveniantur species incerti, ut ita dicam, laris, et ad plura genera revocabilis. Nec enim id patitur natura rei. Nam, cùm Natura (ut dici solet) non faciat saltus, neque ab extremo ad extremum transeat nisi per medium, inter superiores et inferiores, rerum ordines nonnullas mediæ et ambigux conditionis producere solet, quæ de utroque participant, et utrosque velut connectant, ut ad utrum pertineant omninò incertum sit. Præterea eadem alma parens in methodi cujuscunque angustias coerceri repugnat, sed ad libertatem et *αὐτονομίαν* suam nullis legibus obnoxiam ostentandam, in unoquoque rerum ordine nonnullas species creare solet, tanquam exceptiones à regulis generalibus, singulares et anomalas. — RAN, *Hist. Plant.* vol. i. Præf.

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New-Street-Square.

THE idea of this book was suggested to me by the difficulty experienced by all teachers, in explaining to their students what are the most prominent and important points in Botany, on which to fix their attention. I found that when axioms are thrown into an extended and descriptive form, and mixed up with discussions which are only incidental to them, the student is apt to lose sight of the exact nature of the argument, and to confound different phenomena from want of the power of disentangling the more essential from the less essential subjects. It is clear, that, without a distinct perception of the exact nature of the first principles of any science, no one can hope to apply it to practical purposes with any probability of success.

These considerations originally led to the publication of my "Outline of the First Principles of Botany," wherein the fundamental propositions upon which the principles of Organic and Physiological Botany depend were stated as briefly as the nature of the subject would permit. The success with which this little book was received, and its recognised utility to students, whatever its defects may have been, induced me to attempt the far more difficult task of reducing the definitions employed in the higher part of Systematic Botany to their simplest form, and to show that the impediments which accompany this branch of the science are susceptible of being very materially diminished by a careful and extensive kind of analysis. The "Nixus Plantarum" was written with the view of putting to the test the possibility of executing such a plan, and it has been extremely satisfactory to me to find that this work also, although in many respects totally unsuited to the use of students, has nevertheless been in many cases employed by them with singular advantage.

As both the "Outline of First Principles" and the "Nixus" are out of print, I have determined to combine them into one work, — a sort of Botanical Note-Book, — wherein all the principal topics which the teachers of Botany either do, or ought to, introduce into their lectures are arranged methodically. The student will naturally look to his instructor for explanations and illustrations of the work, and for the exposition in detail of those points which in his Note-Book are merely adverted to.

In the systematic part, I have endeavoured to secure as much distinctness in all respects as the resources of printing would

supply; knowing, from experience, how difficult it is to convey to the mind a clear and distinct impression of any thing which is presented to the eye in a state of confusion. I have also ventured to reform the language of Botanists in some respects, by carrying out their own principles to their full extent; thus securing a more uniform kind of nomenclature, and expressing the value of the names of the classes, orders, &c., in all cases, by the manner of their termination.

Let me add in conclusion, that no student ought to conceive himself sufficiently acquainted with Botany, until he can bear an examination in the whole of the structural and physiological part of this work, and in the systematic part as far as the orders marked **B** are concerned.

University of London,
Sept. 15, 1835.

CONTENTS.

	Page
I. Elementary Organs.....	5
II. Compound Organs.....	9
III. Root.....	9
IV. Stem.....	10
V. Leaf-buds.....	13
VI. Leaves.....	15
VII. Hairs.....	17
VIII. Food and Secretions.....	17
IX. Flower-buds.....	20
X. Inflorescence.....	21
XI. Floral Envelopes.....	23
XII. Male Organs — Stamens.....	25
XIII. Disk.....	27
XIV. Female Organs — Pistil.....	27
XV. Ovule.....	30
XVI. Fruit.....	31
XVII. Seed.....	34
XVIII. Flowerless Plants.....	38
XIX. Systems.....	39
XX. Linnean Artificial Scheme.....	41
XXI. Natural System.....	41

KEY
TO
STRUCTURAL, PHYSIOLOGICAL, AND SYSTEMATIC
BOTANY.

1. PLANTS are not separable from animals by any absolute character; the simplest individuals of either kingdom not being distinguishable by our senses.

2. Animals are for the most part incapable of multiplying by mechanical or spontaneous division of their trunk, and are supported by nutritious matter, carried into their system from an internal bag or stomach.

3. Plants are for the most part congeries of individuals, multiplying by spontaneous or artificial division of their trunk or axis, and are supported by nutritious matter conveyed into their system by the absorption of their lower extremities or roots.

4. Generally speaking, the latter are fixed to some substance from which they grow, are destitute of locomotion, and are enabled to digest their food by the action of light upon their cuticle (38.).

5. Plants consist of a membranous transparent tissue, chemically composed of a hygrometrical combination of oxygen, hydrogen, and carbon, to which nitrogen is occasionally superadded. They are also found to contain many mineral substances, which they are supposed to separate from their proper food during the process of digestion, and to deposit in their tissue (216.).

6. Their tissue appears under three forms, viz. cellular tissue, woody tissue, and vascular tissue. These are called elementary organs.

I. ELEMENTARY ORGANS.

7. Of these CELLULAR TISSUE (*Tela cellulosa, Lat.; Tissu cellulaire, Fr.; Pulp and Parenchyma, of old writers; Zellgewebe, Germ.*) is the only form universally found in plants; the other forms are often either partially or entirely wanting.

8. Cellular tissue is composed of transparent vesicles, the sides of which are not originally perforated by visible pores (17.).

9. Each vesicle is a distinct individual, cohering with the vesicle with which it is in contact.

10. Therefore, the apparently simple membrane that divides two contiguous cells is in fact double.

11. If the adhesion of the contiguous cells be imperfect, spaces will exist between them. Such spaces are called *intercellular passages*.

12. The vesicles of cellular tissue, when separate, are round or oblong; when slightly and equally pressed together, they acquire a dodecahedral appearance, with a hexagonal section; stretched lengthwise, they become prismatical, cylindrical, or fusiform.

13. Cellular tissue, the vesicles of which fit together by their plane faces, is called *parenchyma*.

14. Cellular tissue, the vesicles of which are elongated and overlies each other at the extremities, is called *prosenchyma*.

15. *Parenchyma* constitutes all the pulpy parts of the medulla or pith (82.), the medullary rays (113.), a portion of the bark (102.), and all that is interposed between the veins of the leaves and of other appendages of the axis. Consequently it is found in every part of a plant, and especially in those which are succulent, such as the pulp of fruit and all the soft parts. It, however, sometimes acquires excessive hardness, as in the stones of fruits, and the bony skins of some seeds.

16. *Prosenchyma* is confined to the bark and wood, in which it is mixed with woody tissue (19.).

17. The function of the cellular tissue is to transmit fluids in all directions; the membrane of which it is composed is, therefore, permeable, although not furnished with visible pores (8.).

18. Cellular tissue is self-productive, one cell generating others upon its surface, either externally or internally. The first mode has been witnessed in *Chara* and *Marchantia*, the latter is a matter of inference.

18. *a. Vascular tissue* is a modification of the cellular, consisting of short truncated cylinders placed end to end, and forming continuous tubes, in consequence of the ends of the cylinders being ruptured and opening into each other. It is common in wood, of which it forms what is vulgarly called the porosity. Its office is to convey fluids with rapidity in the direction of the woody tissue that surrounds it. Formerly it was considered a form of vascular tissue, and called *dotted ducts*.

19. WOODY TISSUE (*Vasa fibrosa*, *Lat.*; *Tissu cellulaire allongé*, *Fr.*; *Clostres*, *Fr.*; *Baströhren*, *Germ.*) consists of elongated tubes tapering to each end, and, like the vesicles of cellular tissue, imperforate to the eye.

20. It may be considered a form of the cellular tissue itself, to which it is frequently referred; but it is practically distinguished by its cylindrical form, great length, extreme fineness, and toughness; the latter of which properties is produced by the thickness of its sides.

21. It is found in the wood, among the *parenchyma* of the liber (104.), and in the veins of the leaves, or other appendages of the axis.

22. Its functions are to give strength to the vegetable fabric, and to serve as a medium for the passage of fluid from the lower to the upper extremities.

23. **VASCULAR TISSUE** (*Trachées, Fr.*) consists of very thin-sided cylinders tapering to each end, and having a spiral fibre generated in their inside.

23. *a.* Of this *spiral vessels* (*Vasa spiralia, Lat.*; *Spiralgefäße, Germ.*) are the type. Their fibre is of a highly elastic nature, and is capable of unrolling when stretched.

24. Spiral vessels are found in the medullary sheath (86.), and in all parts that emanate from it in an ascending direction, viz.: the veins of the leaves, and every thing that is a modification of them.

25. They are generally not found in any part which is formed in a downward direction; and are therefore usually absent from the wood, bark, and root. They, however, occur in these and other unusual parts in a few extremely rare cases; as in the wood, and bark, and pith of *Nepenthes*, and in the roots of many monocotyledons.

26. The spiral vessels convey air containing 7 or 8 per cent. more oxygen than the atmosphere.

27. They scarcely exist except in plants propagated by the agency of sexes.

28. Hence the two primary divisions of the vegetable kingdom, viz.: *Vasculares*, or plants furnished with spiral vessels, and propagated by the agency of sexes; and *Cellulares*, or plants destitute of spiral vessels, and not propagated by the agency of sexes.

29. *Ducts* (*Fausses trachées, Fr.*; *Safröhren, Germ.*) are transparent tubes, the sides of which are marked with rings, bars, or transverse streaks.

30. They are slight modifications of the spiral vessel, differing principally in their being incapable of unrolling; and, in some cases, in the turns of the spiral fibre being distant or broken, or even, in appearance, branched.

31. In those cases where the turns of the spire actually touch each other, the ducts, which are then called *closed*, can only be distinguished from spiral vessels by their inability to unroll; while at rest they appear to be absolutely the same.

32. They are found among the woody tissue of herbaceous plants; are abundant in the wood of the higher tribes of cellular plants, such as *Ferns* and *Lycopodiaceæ*, and their ends are often in immediate connection with the loose cellular tissue occupying the extremities of the fibres of the roots.

33 Their functions have not been accurately determined. It is probable that they act as spiral vessels when young; but, it is certain, that they become filled with fluid, as soon as their spires are separated.

34 With the exception of the cellular (18.), nothing is known of the mode of generation of tissue. But, it has been demonstrated that, the cellular is the type of the other kinds, and that from which

all the rest are modified ; and it is therefore probable that the woody and vascular tissue are generated in a similar way.

35 There are no other elementary forms of tissue. *Air-vessels, Reservoirs of oil, Lenticular glands, Proper vessels*, are all either distended intercellular passages, or cavities built up with cellular tissue. What are now called *vessels of the latex*, are apparently intercellular passages.

36. When such cavities are essential to the existence of a species, they are formed by a regular arrangement of cellular tissue in a definite and unvarying figure ; *Ex.* Water-plants. When they are not essential to the existence of a species, they are mere irregular distensions or lacerations of the tissue ; *Ex.* Pith of the Walnut Tree.

37. All these forms of tissue are enclosed within a skin called the cuticle.

38. The CUTICLE is an external layer of parenchyma, the vesicles of which are compressed, and in a firm state of cohesion.

39. The spaces seen upon the cuticle, when examined by a microscope, represent these vesicles.

40. It is, therefore, not a peculiar membrane, but a form of cellular tissue.

41. It is spread over all the parts of plants which are exposed to air, except the stigma (345.).

41. *a.* It is not found upon parts habitually living under water.

41. *b.* It is itself protected in many cases, by an extremely thin pellicle, which is apparently inorganic and homogeneous.

42. The mass of cellular tissue lying beneath the cuticle of the bark is called the *epidermis*.

43. The cuticle is often furnished with stomates.

44. STOMATES are oval spaces lying between the sides of the cells, opening into intercellular cavities in the subjacent tissue, and bordered by a limb.

45. This appearance of a limb is owing to the juxtaposition of two or more elastic vesicles, closing up or opening the aperture which they form, according to circumstances.

46. Stomates are found abundantly upon leaves, particularly on the lower surface of those organs ; occasionally upon all parts that are modifications of leaves, especially such as are of a leafy texture ; and on the stem.

47. Stomates have not been found upon the roots, nor on colourless parasitical plants, nor the submersed parts of plants, nor on cellular plants destitute of ducts ; they are, moreover, rare, or altogether absent in succulent parts.

48. It frequently happens, that they are so incompletely formed, as to be either altogether incapable of action, or to act in a very imperfect manner ; as in succulent plants.

49. The function of stomates is to regulate evaporation and respiration. It has been thought, that the former function, in particular, is that for which they are destined ; and, that the cause of certain parts becoming succulent, is the absence of stomates, in sufficient numbers to carry off the watery part of the sap. But

some succulent plants have more stomates than ordinary plants, so that this opinion requires reconsideration.

II. COMPOUND ORGANS.

50. From peculiar combinations of the elementary organs are formed the compound organs.

51. The compound organs are the axis (52.) and its appendages (158.).

52. The *axis* may be compared to the vertebral column of animals.

53. It is formed by the developement of a root in one direction, and of an embryo, or of a leaf-bud in the opposite direction.

54. An *embryo* is a young plant, produced by the agency of sexes, and developed within a seed.

55. A *leaf-bud* is a young plant, produced without the agency of sexes, enclosed within rudimentary leaves called scales, and developed on a stem,

56. Seeds propagate the species.

57. Leaf-buds propagate the individual.

58. All the phenomena connected with the growth of plants are caused by an inherent vital action.

59. When the vital action of a seed or bud is excited, the tissue develops in three directions, upwards, downwards, and horizontally.

60. That part which develops downwards is called the descending axis or root; that upwards, the ascending axis or stem; that horizontally the medullary system; and the part from which these two axes start is called the *collet* or neck.

61 This elongation in three directions takes place simultaneously; hence it follows that all plants must necessarily have an ascending and descending axis, or a stem and root, and a medullary system.

62. The only apparent exceptions to this are vesicular Algæ.

III. ROOT.

63. The root is formed by the descending and dividing fibres of the stem.

64. Anatomically it differs from the stem in the absence of spiral vessels (23.), of pith (15.), (in Dicotyledons), of buds, and of stomates (44.).

64. *a.* Although the root has no distinct pith in Dicotyledons, yet it possesses a distinct medullary system.

65. The functions of the root are to fix plants in the earth, and to absorb nutriment from it. They are also supposed to consist in discharging from the system, whatever secretions injurious to itself a plant may form during its growth. So that some plants, at least, not only deprive the earth of nutritious matter, but deteriorate it by the deleterious matter they deposit there.

66. This absorption takes place almost exclusively by the extremities called spongelets, which consist of a lax coating of cellular tissue lying upon a concentric layer of woody tissue, in the midst of which is often placed a bundle of ducts.

IV. STEM.

67. The stem is produced by the successive development of leaf-buds (142), which lengthen in opposite directions.

68. If an annular incision be made below a branch of an Exogenous plant (80), the upper lip of the wound heals rapidly, the lower lip not: the part above the incision increases sensibly in diameter, the part below does not.

69. If a ligature be made round the bark, below a branch, the part above the ligature swells, that below it does not swell.

70. Therefore the matter which causes the increase of Exogenous plants in diameter descends.

71. If a growing branch is cut through below a leaf-bud, that branch never increases in diameter between the section and the first bud below it.

72. The diameter of all Exogenous stems increases in proportion to the number of leaf-buds that is developed.

73. The greater the number of leaf-buds above a given part, the greater the diameter of that part; and *vice versâ*.

74. In the spring the newly forming wood is to be traced in the form of fibres descending from the leaf-buds; that which is most newly formed lying on the outside, and proceeding from the most newly developed buds.

75. Therefore the descending matter, by successive additions of which Exogenous plants increase in diameter, proceeds from the leaf-buds.

76. Their elongation upwards gives rise to new axes, with their appendages; their elongation downwards increases the diameter of that part of the axis which pre-existed, and produces roots.

76. *a.* Roots, therefore, in all cases, should consist of extensions of woody tissue; and this is conformable to observation.

77. Hence, while the stem is formed by the successive evolution of leaf-buds, the root, which is the effect of that evolution, has no leaf-buds.

78. The leaf-buds thus successively developed are firmly held together by the medullary system of the stem, which proceeds from the bark inwards, connecting the circumference with the centre.

79. The stem varies in structure in three principal ways.

80. In vascular plants it is either formed by successive additions to the outside of the wood, when it is called *Exogenous*; or by successive additions to its centre, when it is called *Endogenous*. In Cellular plants it is formed by the union of the bases of the leaves, and by addition to the point of the axis, or by simple elongation or dilatation where no leaves or buds exist, this is called *Acrogenous*.

81. The stem of EXOGENS may be distinguished into the Pith, the Medullary Sheath, the Wood, the Bark, and the Medullary Rays.

82. The PITH consists of cellular tissue, occupying the centre of the stem.

83. It never alters in diameter after it is once formed.

84. It is produced by the elongation of the axis upwards.
85. It serves to nourish the young buds until they have acquired the power of procuring nourishment for themselves.
86. The MEDULLARY SHEATH consists of spiral vessels.
87. It immediately surrounds the pith, projections of which pass through it into the medullary rays (113.).
88. It is in direct communication with the leaf-buds and the veins of the leaves.
89. It carries upwards the superfluous oxygenated air, either absorbed immediately from the earth, or obtained in part by the decomposition of carbonic acid (101.), and conducts it into the leaves.
90. The WOOD lies upon the medullary sheath, and consists of concentric layers.
91. It is formed by the successive adhesion of the descending axes of the buds, and by the interposition of the medullary system, here called medullary rays, connecting the pith and the bark.
92. The first concentric layer lies immediately upon the medullary sheath and pith, and consists of woody and vasiform tissue (18. a).
93. Each succeeding concentric layer consists of woody and vasiform tissue, which either form themselves into distinct strata, in which case the latter is innermost, or are confounded together.
94. When there is any material difference between the compactness of the tissue of the two sides of a concentric layer, zones are formed in which the woody tissue is outermost; but when the vasiform and woody tissues are equally intermingled, no apparent zones exist.
95. A concentric layer, once formed, never alters in dimensions.
96. Each concentric layer, which is distinctly limited, is usually the produce of one year's growth.
97. Therefore, the age of an Exogenous tree should be known by the number of concentric circles of the wood. But this rule is of uncertain application, owing to numerous disturbing causes, especially in countries in which the period of rest is less distinctly marked than in the winter of northern latitudes.
98. The secretions of plants are deposited first in the oldest concentric layers; while those layers which are most recently formed are either empty, or contain but a slight deposit.
99. When the tissue of the concentric layers is filled with secretions, it ceases to perform any vital functions.
100. The dead and fully formed central layers are called the *heart-wood*.
101. The living and incompletely formed external layers are called the *alburnum*.
102. Upon the outside of the wood lies the BARK, which, like the wood, consists of concentric layers.
103. Each concentric layer is composed of woody tissue, mixed with, and covered externally by, a layer of cellular tissue.
104. The woody tissue constitutes the *liber*.
105. The exterior cellular tissue constitutes the cellular integument or *epidermis*.

106. The concentric layers of the wood and bark are the reverse of each other, the former increasing externally, the latter internally.

107. The concentric layers of the bark are formed at the same period, and under the same circumstances, as those of the wood.

108. Therefore, the number of concentric layers in the one or the other is the same.

109. But while the concentric layers of the wood are imperishable except from disease, those of the bark are continually destroyed by the distension of the stem; and hence the bark is always perishing naturally, while the wood sustains no loss.

110. The secretions of a plant are often deposited in the bark in preference to any other part.

111. Hence chemical or medicinal principles are often to be sought in the bark rather than in the wood.

112. The immediate functions of the bark are to protect the young wood from injury, and to serve as a filter through which the descending elaborated juices of a plant may pass horizontally into the stem, or downwards into the root.

113. The MEDULLARY RAYS OR PLATES consist of compressed parallelograms of cellular tissue (*muriform cellular tissue*), belonging to the medullary system.

114. They connect together the tissue of the trunk, maintaining a communication between the centre and the circumference.

115. They act as braces to the woody and *vasiform* tissue of the wood. They convey secreted matter horizontally from the bark to the heart-wood, and they generate adventitious leaf-buds (153.).

116. *Cambium* is a viscid secretion which, in the spring, separates the alburnum of an Exogenous plant from the liber.

117. It is supposed to be destined to afford a proper pabulum for the descending fibres of the buds.

118. It is also, in all probability, the organising matter in which the cellular tissue of the medullary system is engendered, for the purpose of extending the medullary plates, and maintaining the communication between the bark and central part of a stem.

119. As Exogenous plants increase by annual addition of new matter to their outside, and as their protecting integument or bark is capable of distension in any degree, commensurate with the increase of the wood that forms below it, it follows, taking all circumstances into consideration, that there are no assignable limits to the life of an Exogenous tree.

120. The stem of ENDOGENOUS plants offers no distinction of Pith, Medullary Rays, Wood, and Bark.

121. It is formed by the intermixture of bundles of vascular tissue among a mass of cellular tissue, the whole of which is surrounded by a zone of cellular and woody tissue, inseparable from the stem itself, and therefore not bark.

122. It increases by the successive descent of new bundles of vascular tissue down into the central cellular tissue, curving outwards as they descend.

123. The vascular bundles of the centre gradually force outwards those which were first formed, the cellular mass augments simultaneously, and in this way the diameter of a stem increases.

124. The diameter of the stem of an Endogenous plant is determined by the power its tissue possesses of distending, and on its hardness.

125. When the external tissue has once become indurated, the stem can increase no further in diameter.

126. When the tissue is soft and capable of continual distension, there is no more certain limits to the life of an Endogenous than of an Exogenous tree.

127. Generally, the terminal bud only of Exogenous plants is developed; but very often a considerable number develope; *Ex. Asparagus.*

128. When a terminal bud only of an Endogenous plant develops, the stem is cylindrical; *Ex. Palms*; when several develope, it becomes conical; *Ex. Bamboo.*

129. In *Acrogenous* plants no other stem is formed than what arises from the simple union of the bases of the leaves to the original axis of the bud from which they spring, and which they carry up along with them. This subject is but ill understood.

129. *a.* When *Acrogenous* plants have no proper leaves, they are mere expansions of cellular matter, sometimes in all directions; *Ex. Fungi*: sometimes in particular directions; *Ex. Lichens, Algæ, &c.*

130. The ascending direction of the stem, upon its first development, is frequently deviated from immediately after.

131. It often burrows beneath the earth, when it is vulgarly called a *creeping root*. Sometimes the internodes (137.), become much thickened, when what are called *tubers* are formed; or the stem lies prostrate upon the earth, emitting roots from its under side, when it is called a *rhizoma*, or rootstock.

132. If it distend underground, without creeping or rooting, but always retaining a round or oval figure, it is called a *cormus*.

133. All these forms of stem are vulgarly called roots.

134. No root can have either scales, which are the rudiments of leaves, or nodes, which are the rudiments of buds. A *scaly root* is, therefore, a contradiction in terms.

135. The ascending axis, or stem, has nodes and internodes.

136. *Nodes* are the places where the leaves are expanded and the buds formed.

137. *Internodes* are the spaces between the nodes.

138. Whatever is produced by the evolution of a leaf-bud (142.) is a branch.

139. A *spine* is the imperfect evolution of a leaf-bud, and is, therefore, a branch.

140. All processes of the stem which are not the evolutions of leaf-buds, are mere dilatations of the cellular integument of the bark. Such are *prickles*. (*Aculei*, Lat.)

V. LEAF-BUDS.

141. Buds are of two kinds, Leaf-buds and Flower-buds.

142. *LEAF-BUDS* (*Bourgeon*, Fr.) consist of rudimentary leaves

surrounding a growing vital point, the tissue of which is capable of elongation, upwards in the form of stem, and downwards in the form of wood or root.

143. FLOWER-BUDS (*Bouton*, Fr.) consist of rudimentary leaves surrounding a fixed point, and assuming, when fully developed, the form of floral envelopes or sexual apparatus.

144. Notwithstanding this difference, a leaf-bud sometimes indicates a tendency to become a flower-bud; and flower-buds frequently assume the characters of leaf-buds; *Ex.* Monstrous Pears.

145. Leaf-buds are of two kinds, the regular and the adventitious.

146. *Regular* Leaf-buds are only found in the axils of leaves.

147. They exist in a developed or undeveloped state in the axils of all leaves, and of all modifications of leaves.

148. Therefore, they may be expected to appear at the axils of scales of the bud, of stipules (183.), of bracts (229.), of sepals (290.), of petals (291.), of stamens (302.), and of carpels (354.); in all of which situations they are generally undeveloped; for these different organs are all modifications of leaves.

149. They are frequently not called into action, even in the axils of leaves.

150. As regular buds are only found in the axils of leaves, or of their modifications; and as branches are always the development of buds, it follows that whatever may be the arrangement of the leaves, the same will be the disposition of the branches; and *vice versâ*.

151. This corresponding symmetry is, however, continually destroyed by the unequal development of the buds.

152. Leaf-buds which are formed among the tissue of plants subsequently to the development of the stem and leaves, and without reference to the latter, are called latent, adventitious, or abnormal.

153. *Adventitious* Leaf-buds may be produced from any part of the horizontal medullary system, or, wherever cellular tissue is present. It has been distinctly proved, that while roots are prolongations of the vertical or woody system, leaf-buds universally originate in the horizontal or cellular system.

154. They are formed in the root, among the wood, and at the margin or on the surface of leaves.

155. They are constructed anatomically exactly as regular buds, having pith in their centre, surrounded by a medullary sheath of spiral vessels, and coated over by woody tissue and cellular integument.

156. Hence, as adventitious buds, containing spiral vessels, can be produced from parts such as the root or the wood, in which no spiral vessels previously existed, it follows that this form of tissue is either generated spontaneously, or is produced by some other tissue, in a manner unknown to us. It is most probable, that spiral vessels are spontaneous modifications of vesicles of cellular tissue, as has been before stated (34.).

157. Leaf-buds have been sometimes confounded with roots by old botanists. A *bulb* is a leaf-bud; a *bulbous root* is a contradiction in terms.

VI. LEAVES.

158. A leaf is an expansion of the bark immediately below the origin of a regular leaf-bud, and is an appendage of the axis (51).

159. Whenever a regular leaf-bud is formed, a leaf, either perfect or rudimentary, is developed also; and *vice versâ*.

160. Leaves are developed alternately, one above and opposite the other, around their common axis; but sometimes in consequence of the internodes being unequally developed, leaves become opposite or verticillate. They are never produced side by side.

161. In Exogenous plants, the primordial or seed-leaves (cotyledons) are opposite; hence, in such plants the supposed non-development of the axis takes place during the original formation of the embryo.

162. There is a constant tendency in opposite or verticillate leaves to become alternate.

163. This law applies equally to the arrangement of all parts that are modifications of leaves.

164. A leaf consists of a petiole or stalk, a lamina or blade, and a pair of stipules.

165. The PETIOLE is the channel through which the vessels of the leaf are connected with those of the stem; it is formed of one or more bundles of spiral vessels and woody tissue, enclosed in a cellular integument.

166. The spiral vessels of the leaf of Exogenous plants derive their origin from the medullary sheath; those of Endogenous plants from the bundles of vascular tissue.

167. The cellular integument of the petiole is a continuation of that of the bark.

168. When the petiole is leafy and the lamina is abortive, it is called *phyllodium*.

169. When the petiole becomes dilated and hollowed out at its upper end, the lamina being articulated with and closing up its orifice, it is called a *pitcher* or *ascidium*.

170. Sometimes the petiole has no lamina, or is elongated beyond the lamina, and retains its usual cylindrical or taper figure, but becomes very long, and twists spirally; such a petiole is called a *tendrill* (Vrille, Fr.).

171. The LAMINA of a leaf is an expansion of the parenchyma of the petiole, and is traversed by veins which are ramifications or extensions of the bundles of vascular tissue of the petiole, or, when there is no petiole, of the stem.

171. *a*. Sometimes one, sometimes both the surfaces of a leaf are furnished with stomates.

172. The veins either branch in various directions among the parenchyma, anastomosing and forming a kind of net-work, or they run parallel to each other, being connected by single transverse unbranched veins.

173. The former is characteristic of Exogenous, the latter of Endogenous plants.

174. The principal vein of a leaf is a continuation of the petiole, and runs in a direct line from the base to the apex of the lamina; this vein is called the *midrib*.

175. *Coniferae* and *Cycadeæ*, tribes the stem of which has an Exogenous structure, have the same arrangement of their veins as Endogens.

176. There are two strata of veins, the one belonging to the upper, and the other to the under surface.

177. The upper stratum conveys the juices from the stem into the lamina, for the purpose of being aërated and elaborated; the under returns them into the bark.

178. The lamina is variously divided and formed; it is usually thin and membranous, with a distinct upper and under surface; but sometimes becomes succulent, when the surfaces are often not distinguishable.

179. The upper surface is presented to the sky, the lower to the earth; this position is rarely departed from in nature, and cannot be altered artificially except by violence.

180. A leaf is *simple* when its lamina is undivided, or when, if it is separated into several divisions, those divisions are not articulated with the petiole; *Ex.* Lime Tree, Palm.

181. A leaf is *compound* when the lamina is articulated with the petiole; *Ex.* Orange, Mimosa.

182. The modes in which leaves are divided are distinguished by particular names, such as, *pinnated*, *pinnatifid*, *bipinnated*, *bipinnatifid*, and very many others. These terms apply to the mode of division, and are equally applicable to simple and compound leaves.

183. *STIPULES* are attached to each side of the base of the petiole. They have, if leafy, veins, the anatomical structure of which is the same as that of the veins of the leaves.

183. *a.* Sometimes, only one stipule is formed, the other being constantly abortive, as in Azara.

184. Stipules are sometimes transformed into leaves; they sometimes have buds in their axils; and may be, therefore, considered rudimentary leaves.

185. Whatever arises from the base of a petiole, or of a leaf if sessile, occupying the same place, and attached to each side, is considered a stipule.

186. The stipules must not be confounded with cellular marginal appendages of the petiole, as in Apocynæ.

187. Stipules, the margins of which cohere in such a way that they form a membranous tube sheathing the stem, are called *ochreae*; *Ex.* Rhubarb.

188. All leaves are originally continuous with the stem; as they grow, an interruption of their tissue at their junction with the stem takes place, by which a more or less complete articulation is formed sooner or later.

189. The articulation between a leaf and stem being completed, the tissue of the former becomes gradually incrustated by the foreign

matter deposited by the sap in the process of secretion and digestion, and at last is incapable of further action, when it dies. The stem, however, continues to increase in diameter; and as a dead leaf will not increase with it, the latter is eventually thrown off; this is the fall of the leaf. But in some leaves the articulation is so slight, that the leaf is never thrown off, but simply withers and decays; *Ex.* Grasses, Palms, &c.

190. All leaves ultimately fall off; evergreen leaves later than others.

191. The mode in which leaves are arranged within their bud is called *vernation*, or *gemma*tion.

192. Leaves have, under particular circumstances, the power of producing leaf-buds from their margin (154.); *Ex.* Bryophyllum, *Malaxis paludosa*, and proliferous Ferns.

VII. HAIRS.

193. Hairs are minute expansions of transparent cellular tissue proceeding from the surface of plants. They are of two kinds, lymphatic and secreting.

194. *Lymphatic* hairs are formed by vesicles of cellular tissue placed end to end, and not varying much in dimensions.

195. *Secreting* hairs are formed by vesicles of cellular tissue placed end to end, and sensibly distended at the apex or base into receptacles of fluid.

196. Lymphatic hairs are for the protection of the surface on which they are placed, and for the control of evaporation through the stomates (44.). They always proceed from the veins, while the stomates occupy the interjacent parenchyma.

197. Secreting hairs are receptacles of the fluid peculiar to certain species of plants, such as the fragrant volatile oil of the sweet briar, and the acrid colourless secretion of the nettle.

VIII. FOOD AND SECRETIONS.

198. Plants are nourished by the absorption of food from the earth, in consequence of which they grow, and produce their peculiar secretions.

199. The growth of plants is very rapid; that of the leaves is such that they often acquire six or seven times their original weight per hour.

200. The food of plants consists of water, holding various substances in solution.

200. *a.* The roots have the power of absorbing these substances, without, however, possessing the means of separating one thing from another, except in cases where the elementary molecules of the matter presented to the roots, are larger than the invisible pores through which such molecules should pass; *Ex.* coloured infusions; or in the instance of Strontian, and probably, some other unexamined bodies, the cause of whose rejection is unknown.

201. As soon as food is absorbed, it begins to ascend into the stem.

202. The ascending fluid is called *sap*; it consists chiefly of

water, mucilage, and sugar, mixed with mineral matter and a small quantity of such peculiar secretions of the plant as it may dissolve in its course. It does not alter its nature materially until it is discharged into the leaves.

202. *a.* But it parts with a large proportion of its water, which is actually solidified and incorporated with the tissue, to which it gives strength and thickness.

203. Sap is put in motion by the newly developing leaf-buds, which, by constantly consuming the sap that is near them, attract it upwards from the roots as it is required. Therefore, the movement of the sap is the effect, and not the cause, of the growth of plants. It depends upon vital irritability, and is independent of mechanical causes.

204. This *irritability* is indicated not only by the motion of the sap, but by several other phenomena of vegetation : such as,

204. *a.* The elasticity with which the stamens sometimes spring up when touched, and the sudden collapse of many leaves when stimulated.

204. *b.* The apparently spontaneous oscillation of the labellum of some Orchideous plants.

204. *c.* The expansion of flowers and leaves under the stimulus of light, and the collapse of them when light is withdrawn. This phenomenon in leaves is called the *sleep of plants*.

204. *d.* By the effects of mineral and vegetable poisons being the same upon plants as upon animals. Mineral poisons kill by inflammation and corrosion ; vegetable poisons by the destruction of irritability.

205. After the sap has been distributed through the veins of the leaves, it becomes exposed to the influence of air and light, and undergoes peculiar chemical changes. In this state it is called the *proper juice*.

206. When the proper juice has been once formed, it flows back along the lower stratum of veins (176.), and descends towards the roots, passing off horizontally into the centre of the stem.

207. Hence the great importance of leaves to plants, and the necessity of exposing them to the full influence of light and air, for the purpose of securing a due execution of their natural functions,

208. Hence also the impropriety of mutilating plants by the destruction of their leaves.

209. In Exogenous plants (80.) the upward course of the fluids is through the young wood, their downward passage through the bark, towards, or into the root, and their horizontal diffusion takes place by the medullary rays.

210. Hence the peculiar principles of such plants are, in trees and shrubs, to be sought either in the bark or the heart-wood (100.), not in the alburnum (101.). But in plants whose stems are annually destroyed while the roots are perennial : the latter are the sole reservoir of secretions ; and in annuals, whose root and stem both perish, the secretions are dispersed equally through the stem and root.

211. As they are the result of the growth of a plant, they will be found more abundantly in annual plants at the end than at the commencement of their growth.

212. In Endogenous plants (80.) it is probable that the upward course of the fluids is through the bundles of vascular and woody tissue, and that the downward and horizontal passage takes place through the cellular tissue.

213. The precise direction of the sap in Acrogens (80.) is unknown.

214. Besides mucilage, water, and sugar, plants contain several other principles either proximate or accessory.

215. The proximate principles are formed by the vital powers of the plant acting, in conjunction with air and light, upon the fluids introduced into its system.

216. Many accessory or foreign principles are also found in plants, such as silex, phosphate of lime, phosphorus, iron, copper, &c.

217. As it has been ascertained, by experiment, that these are not formed in plants unless their aliment contained them, it is inferred that the presence of such principles depends upon the power which the vital principle possesses of separating them from the sap with which they were introduced into the system in a state of solution.

218. The most important chemical phenomenon connected with the growth of plants, is the property possessed by their leaves, or green parts, of absorbing oxygen, and forming and losing carbonic acid gas in the dark ; and of parting with oxygen, by the decomposition of carbonic acid, under the influence of the sun.

219. The alternate action of this phenomenon is supposed to cause, in conjunction with the peculiar vital powers of particular species, all the variety of proximate and foreign principles found in vegetation.

220. No plants can long exist in which an alternate absorption and expulsion of oxygen, or composition and decomposition of carbonic acid, does not take place, except Fungi, or brown parasites.

221. The expulsion of oxygen is determined by the quantity of light to which a plant is exposed. Light causes the decomposition of carbonic acid gas, and the accumulation of solid matter.

222. Hence, if a plant is exposed to too strong a light, it perishes, from the excessive expulsion of oxygen and accumulation of carbon.

223. And if it is not exposed to the influence of light, it dies from the accumulation of oxygen.

224. If there is too great an accumulation of oxygen, an attempt will always be made by a plant to reach the light, for the purpose of parting with the superfluity ; as in seeds, which, in germination, shoot from darkness into light.

225. If this cannot be effected, *etiolation* first takes place, which is caused by the accumulation of oxygen, and the non-decomposition of carbonic acid ; and death succeeds.

226. Seeds will not germinate in the light, because light de-

composes their carbonic acid gas, expels the oxygen, and fixes the carbon, whence all the parts become hardened.

226. *a.* It is necessary, in order that germination may proceed advantageously, that the superfluous carbon stored up in seeds should be parted with by the absorption of oxygen, the formation of carbonic acid and its subsequent expulsion, and these effects can only take place in darkness (218.).

IX. FLOWER-BUDS.

227. The FLOWER-BUD (143.) consists of a growing point, surrounded by imbricated, rudimentary, or metamorphosed leaves, the external or inferior of which are usually alternate, and the internal or superior always verticillate, or opposite; the latter are called *floral envelopes* and *sexes*.

228. As every flower-bud proceeds from the axil of a leaf, either fully developed or rudimentary, it therefore occupies exactly the same position with respect to the leaf as a leaf-bud.

229. The leaf from the axil of which a flower-bud arises, is called *bract* or *flower leaf*; and all rudimentary leaves, of what size or colour soever, which appear on the peduncle between the floral leaf and the calyx, are called *bracteolæ* or *bractlets*.

230. But in common language, botanists constantly confound these two kinds, which are, nevertheless, essentially distinct.

231. Although the buds in the axils of bracts are often not developed, yet they have the same power of developement as those in the axils of leaves; they are generally flower-buds, very rarely leaf-buds.

232. When a single bract is rolled together, highly developed, and coloured, and is placed at the base of that form of inflorescence called a spadix (259.), it is named *spathe*; *Ex.* Arum.

233. When several bracts are verticillate or densely imbricated around the base of the forms of inflorescence called the umbel, or capitulum (261.), they receive the name of *involucre*; *Ex.* Carrot, Daisy.

234. When the bracts of an involucre form a single whorl, and cohere by their margins, it is impossible to distinguish them from the calyx by any other mark than by their position, and by their usually surrounding more flowers than one.

235. The minute or colourless bracts at the base of the florets of a capitulum (261.) are called *paleæ*.

236. Small imbricated bracts are often called *scales*.

237. Bracts, when placed immediately below the sexes, as in apetalous flowers, are only distinguished from the calyx by being alternate with each other, and not verticillate; hence the *glumes* and *paleæ* of grasses are bracts and not calyx.

238. The axis of the flower-bud in its natural state does not lengthen beyond those upper series of metamorphosed leaves which constitute the sexes.

239. The lengthened part of the axis, from the point of its connection with the stem, as far as the floral envelopes, is called the *peduncle*.

240. When several peduncles spring from the axis at short distances from each other, the axis receives the name of *rachis*, and the peduncles themselves are called *pedicels*.

241. There is never more than one flower to each peduncle, strictly speaking; therefore, when we speak of a two-flowered peduncle, we only mean that two flowers, each having its peculiar pedicel, terminate the axis, which is then considered a peduncle common to each pedicel.

242. Every flower, with its peduncle and bractlets, being the development of a flower-bud, and flower-buds being altogether analogous to leaf-buds, it follows, as a corollary, that every flower, with its peduncle and bractlets, is a metamorphosed branch.

243. And further, the flowers being abortive branches, whatever are the laws of the arrangement of branches with respect to each other, the same will be the laws of the arrangement of flowers with respect to each other.

244. Flower-buds, however, being much less subject to abortion than leaf-buds, flowers are more symmetrically disposed than branches, and appear to possess their own peculiar order of development.

245. As flower-buds can only develop from the axil of a bract, it follows, that while a pedicel without bracts can never accidentally produce other flowers, any one-flowered pedicel, on which bracts are present, can, and frequently does, bear several flowers.

246. In consequence of a flower and its peduncle being a branch in a particular state, the rudimentary or metamorphosed leaves which constitute bracts, floral envelopes, and sexes, are subject to exactly the same laws of arrangement as regularly formed leaves.

247. The modes in which the flower-buds are arranged are called *forms of inflorescence*; and the order in which they unfold is called the *order of expansion*.

X. INFLORESCENCE.

248. Inflorescence is the ramification of that part of the plant intended for reproduction by seed.

249. The greater development of some forms of inflorescence than of others, is owing to the greater power one plant possesses than another of developing buds, latent in the axils of the bracts.

250. A flower-bud may either develop into a single flower, or may follow the laws of increase of leaf-buds, and give birth to many other flower-buds.

251. In consequence of flower-buds obeying the laws which regulate leaf-buds, all forms of inflorescence must, of necessity, be axillary.

252. Those forms which are called *opposite the leaves*, *extra-axillary*, *petiolar* or, *epiphyllous*, and even the *terminal* itself, are mere modifications of the axillary.

253. The kinds of inflorescence which botanists more particularly distinguish are the following:—

254. When no elongation of the general axis of a plant takes

place beyond the developement of a flower-bud, the flower becomes what is called *terminal* and *solitary*; *Ex.* Pæony.

255. When a single flower-bud unfolds in the axil of a leaf, and the general axis continues to lengthen, and the leaf undergoes no sensible diminution of size, the flower which is developed is said to be *solitary* and *axillary*.

256. If all the buds of a newly formed elongated branch develop as flower-buds, and at the same time produce peduncles, a *raceme* is formed.

257. If buds, under the same circumstances, develop without forming peduncles, a *spike* is produced.

258. Hence the only difference between a spike and raceme is, that in the former the flowers are sessile, and in the latter stalked.

259. A *spadix* differs from a spike, in nothing more than in the the flowers being packed close together upon a succulent axis, which is enveloped in a spathe (232.).

260. An *amentum* is a spike the bracts of which are all of equal size, and closely imbricated, and which is articulated with the stem.

261. When a bud produces flower-buds, with little elongation of its own axis, either a *capitulum* or an *umbel* is produced.

262. The capitulum bears the same relation to the umbel as the spike to the raceme; that is to say, these two forms differ in the flower-buds of the capitulum being sessile, and of the umbel having pedicels.

263. The dilated depressed axis of the capitulum is called the *receptacle*.

264. A raceme, the lowest flowers of which have long pedicels, and the uppermost short ones, is a *corymb*.

265. A *panicle* is a raceme, the flower-buds of which have, in elongating, developed other flower-buds.

266. A panicle, the middle branches of which are longer than those of the base or apex, is called a *thyrsus*.

267. A panicle, the elongation of all the ramifications of which is arrested, so that it assumes the appearance of an umbel, is called a *cyme*.

268. In all modes of inflorescence which proceed from the buds of a single branch, the axis of which is either elongated or not, the flowers expand first at the base of the inflorescence, and last at the summit. This kind of expansion is called *centripetal*.

269. When the uppermost or central flowers open first, and those at the base or the circumference last, the expansion is called *centrifugal*.

270. The centripetal order of expansion always indicates that the inflorescence proceeds from the developement of the buds of a single branch.

271. When inflorescence is the result of the developement of several branches, each particular branch follows the centripetal law of expansion, but the whole mass of inflorescence the centrifugal.

272. This arises from the partial centripetal developement commencing among the upper extremities of the inflorescence instead of among the lower.

273. Consequently, this difference of expansion will indicate whether a particular form of inflorescence proceeds from the developement of the buds of a single branch, when it is called *simple*, or not, when it is called *compound*.

274. Whenever the order of expansion is centripetal, the inflorescence is to be understood as *simple*; when it is centrifugal, it is *compound*, although in appearance *simple*. This difference is often of great importance.

275. When the order of expansion is irregular, it indicates that the mode of developement of the flowers is irregular also, either on account of abortion or other causes.

276. Sometimes all the flowers of the inflorescence are abortive, and the ramifications, or the axis itself, assume a twisted or spiral direction; when this happens, a *tendrîl* is formed; *Ex.* the Vine.

XI. FLORAL ENVELOPES.

277. The Floral Envelopes are the parts which immediately surround the sexual organs.

278. They are formed of one or more whorls of bracts, and are therefore modified leaves (229.).

279. In anatomical structure they do not essentially differ from the leaves, farther than is necessarily consequent upon the peculiar modifications of size or developement to which they are subject.

280. When the floral envelopes consist of but one whorl of leaves, they are called *calyx*.

281. When two or more whorls are developed, the outer is called *calyx*, the inner *corolla*.

282. There is no other essential difference between the *calyx* and *corolla*. Therefore, when a plant has but one floral envelope, that one is *calyx*, whatever may be its colour or degree of developement.

283. It is necessary, however, to be aware, that sometimes the *calyx* is reduced to a mere rim, either in consequence of lateral compression, as in the *pappus* (*aigrette*, Fr.) of many *Compositæ*, or from other unknown causes, as in some *Acanthacæ*.

284. If the floral envelopes are of such a nature that it is not obvious whether they consist of both *calyx* and *corolla*, or of *calyx* only, they receive the name of *perianthium* or *perigonium*.

285. Plants have frequently no floral envelopes; in that case, flowers are said to be *naked* or *achlamydeous*.

286. When the floral envelopes are deciduous, they fall from the peduncle, as leaves from a branch, by means of an articulation; if they are persistent, it is because no articulation exists.

287. When the margins of floral envelopes are united, the part where the union has taken place is called the *tube*, and that where they are separate is named the *limb*. It frequently happens that

in the calyx an articulation forms between the limb and the tube.

288. Botanists generally consider that the tube of the calyx is invariably formed by the union of the margins of the sepals. It is, however, probable, that it is in some cases a mere dilatation and expansion of the pedicel itself, as in *Eschscholtzia*.

289. When the calyx and corolla are readily distinguishable from each other, they exhibit the following peculiarities:—

290. The *calyx* consists of two or more divisions, usually green, called *sepals*, which are either distinct, when a calyx is said to be *polysepalous*, or which unite by their margins in a greater or less degree, when it is called *monosepalous*, *gamosepalous*, or *monophyllous*.

291. The *corolla* consists of two or more divisions, called *petals*, usually of some bright colour, different from that of the sepals, than which they are frequently more developed. When the petals are distinct a corolla is said to be *polypetalous*; when they are united by their margins, it is called *gamopetalous* or *monopetalous*.

292. If the union of the petals or sepals takes place in one or two parcels, the corolla or calyx are said to be one or two-lipped. These lips are always anterior and posterior with respect to the axis of inflorescence, and never right and left.

293. If the sepals or petals are of unequal size, or unite in unequal degrees, the calyx or corolla is said to be *irregular*.

293. *a.* If the sepals and petals are unequal in number, or no multiple of each other, or if the stamens are neither equal to them in number, nor any power of them, a flower is said to be *unsymmetrical*.

294. When the petals are so arranged, that of five the uppermost is dilated, the two lateral ones contracted and parallel with each other, and the two lower also contracted, parallel with each other, and coherent by their anterior margins, a flower is said to be *papilionaceous*.

295. When a petal tapers conspicuously towards the base, it is said to be *unguiculate*; its lower part is called the *unguis*, its upper the *limb*. The former is analogous to the petiole, the latter to the lamina of a leaf.

296. The petals always alternate with the sepals, a necessary consequence of their following the laws of developement of leaves.

297. If at any time the petals arise from before the sepals, such a circumstance is due to the abortion of one whorl of petals between the sepals and those petals which are actually developed.

298. As petals always alternate with sepals, the number of each row of either will always be exactly the same. All deviations from this law are either apparent only, in consequence of partial cohesions, or if real, are due to partial abortions.

299. Whatever intervenes between the bracts and the stamens belongs to the floral envelopes, and is either calyx or corolla; of which nature are many of the organs vulgarly called *nectaries*.

300. The dilated apex of the pedicel, from which the floral envelopes and stamens arise, is called the *torus* or *receptacle*. It is the *growing point* of a flower-bud.

301. The manner in which the floral envelopes are arranged before they expand, is called their *æstivation* or *præfloration*.

XII. MALE ORGANS — STAMENS.

302. The whorl of organs immediately within the petals, is composed of bodies called *stamens*, which are considered the male apparatus of plants.

303. They consist of a bundle of spiral vessels surrounded by cellular tissue, called the *filament*, terminated by a peculiar arrangement of the cellular tissue, in a case, finally opening and discharging its contents, called the *anther*.

304. There are many instances in which no limits can be traced between the petals and stamens; *Ex.* Nymphæa.

305. In such cases it is found that the limb (295.) of the petal contracts, and becomes an anther, while the unguis assumes the state of a filament.

306. Now as there are no limits between the petals and sepals (282.), nor between the sepals and bracts (278.), nor between the bracts and leaves (229.), it follows that the stamens are also a modification of leaves.

307. And as the limb of a petal is analogous to the lamina, and the unguis (295.) to the petiole of a leaf, it also follows that the anther is a modification of the lamina, and the filament of the petiole.

308. The stamens follow the same laws of successive development as leaves; and, consequently, if their arrangement be normal, they will be either equal in number to the petals, and alternate with them, or, if more numerous, some regular multiple of the petals.

309. If they are twice the number of petals, two whorls are considered to be developed; and so on.

310. If they are equal in number to the petals, and opposite them, it is to be understood that the innermost only of two whorls is developed, the outermost being abortive.

311. All deviations from these laws are owing to the abortion of some part of the stamens; *Ex.* *Lamium*, *Hippuris*.

312. When the stamens do not contract any union with the sides of the calyx, they are *hypogynous*; *Ex.* *Ranunculus*.

313. When they contract adhesion with the sides of the calyx, they become *perigynous*; *Ex.* *Rose*. This and the last are apparently the same thing.

314. If they are united both with the surface of the calyx and of the ovary, they are *epigynous*; *Ex.* *Umbelliferæ*.

315. The *filaments* (303.) are either distinct or united by their margins. If they are united in one tube, they are called *monadelphous*; *Ex.* *Malva*: if in two parcels, *diadelphous*; *Ex.* *Pea*: if in several, *polyadelphous*; *Ex.* *Hypericum*.

316. When they are united in a solid body, along with the

style, they form what is called a *column*, and are said to be *gynandrous*.

317. The filament is not essential to a stamen, and is often absent,

318. The *anther* is the limb of the stamen, forming within its substance, and finally emitting, a matter called *pollen*.

319. The two sides of the anther are called its *lobes*; and the solid substance which connects them, and which is in fact a continuation of the filament, as the midrib of a leaf is of the petiole, is named the *connective*.

320. The cavities of the anther containing the pollen are the *cells*, and the place by which the pollen is emitted is the point or line of *dehiscence*; the membranous sides of the anther are named the *valves*.

321. Dehiscence usually takes place along a line, which may be considered to indicate the margin of the limb out of which the anther is formed; *Ex.* Rose.

322. Sometimes a portion only of this line opens, and then the anther is said to dehisce by *pores*; *Ex.* Azalea.

323. If the line of dehiscence occupies both margins of the connective, and not the centre of the lobes, the anther opens by one valve instead of two, which is then hinged by its upper edge; *Ex.* Berberry.

324. The cells of the anther are usually two in number: sometimes they are four; *Ex.* Tetratheca: rarely one; *Ex.* Epacris: and still more rarely several; *Ex.* Rafflesia.

325. The number of cells appears to be determined by no certain rule.

326. The anthers frequently grow together by their margins; *Ex.* Compositæ. Such anthers are called *syngenesious*.

327. The *Pollen* is formed by a peculiar modification of the cellules of the parenchyma of the anther.

328. That part of the central cellular tissue of the anther which is not converted into pollen, serves to connect the granules together, in the form of a tenacious fibrous web; *Ex.* *Oenothera*, *Orchis*.

329. Pollen consists of vesicles or granules of cellular tissue, enclosing a mucous substance, in which an infinite number of exceedingly minute molecular bodies having a power of active motion, is contained.

330. The function of the pollen is to vivify the ovules (344.).

331. For this purpose a granule of pollen which has fallen upon the stigma opens, and emits a membranous *tube* filled with the mucus it contains, along with the active molecules floating in it.

332. This tube passes down the intercellular passages of the stigma and style, and is finally conducted into the ovule, through its foramen (408.).

333. In plants, the ovules of which have no pericarpial covering (425.), as *Coniferæ*, the molecules of the pollen are communicated to the ovule without the intervention of any form of tissue.

334. It is supposed that each molecule produces one embryo ; and usually but one is developed in each ovule ; but sometimes two or more accidentally develope, and then a seed contains several embryos, as the Orange, the Onion, the Mistletoe.

XIII. DISK.

335. Whatever intervenes between the stamens and the pistil receives the general name of disk.

336. It usually consists of an annular elevation, encompassing the base of the ovary, when it is sometimes called the *cup* ; *Ex.* Pæony.

337. Or it appears in the form of a glandular lining of the tube of the calyx ; *Ex.* Rose : or of tooth-like, hypogynous (312.), processes ; *Ex.* Gesnera, Cruciferae.

337 *a.* When a fleshy substance occupies the centre of a flower, and bears a single row of carpels, it is called the *gynobase* ; *Ex.* Lamium, Ochna, Geranium, &c. If this substance bears a greater number of carpels than can be arranged in one row, it is called the *receptacle* ; *Ex.* Strawberry, Nelumbium.

338. It is certain that the disk is a non-developement of an inner row or rows of stamens, as is proved by the Moutan Pæony.

339. The receptacle or torus (300.), is the growing point (227.) of the flower-bud in a state of enlargement.

340. The disk is one of the parts which Linnæan botanists call *nectary*.

XIV. PISTIL — FEMALE ORGANS.

341. The organ which occupies the centre of a flower, within the stamens, and disk, if the latter be present, is called the *pistil*.

342. It is the female apparatus of flowering plants.

343. It is distinguished into three parts, viz.: the *ovary*, the *style*, and the *stigma*.

344. The *OVARY* is a hollow case, enclosing *ovules* (354.). It contains one or more cavities, called *cells*.

345. The *STIGMA* is the upper extremity of the pistil.

346. The *STYLE* is the part that connects the ovary and stigma.

347. The style is frequently absent, and is no more essential to a pistil than a petiole to a leaf, or a filament to an anther.

348. Sometimes the style is thin, flat, and membranous, and assumes the form of a petal, as in Iris.

349. The style is either articulated with the ovary, or continuous with it. It usually proceeds directly from the apex of the ovary ; but in some cases arises from the side, or even the base of that organ ; *Ex.* Alchemilla, Chrysobalanæ.

350. Nothing is, properly speaking, stigma, except the secreting surface of the style. Nevertheless, the name is often inaccurately applied to mere divisions of the style, as in Labiatae ; or to the hairy surface of undivided styles, as in Lathyrus.

351. Sometimes the stigmas grow to the face of the anthers, which form themselves into a solid mass ; *Ex.* Asclepias. In this case the styles remain separate.

352. The pistil is either the modification of a single leaf, or of one or more whorls of modified leaves.

353. Such modified leaves are called *carpels*.

354. A CARPEL is formed by a folded leaf, the upper surface of which is turned inwards, the lower outwards; and the margins of which develop one or a greater number of buds, which are the *ovules*.

355. When the carpels are stalked, they are said to be seated upon a *thecaphore*, or *gynophore*; *Ex.* Cleome, Passiflora. Their stalk is analogous to the petiole of a leaf.

355. *a.* When the carpels are all distinct, or are separable with facility, they are *apocarpous*; when they all grow into a solid body, which cannot be separated into its constituent parts, they are *syncarpous*.

356. The ovary is the lamina of the leaf.

357. The style is an elongation of the midrib (174.).

358. The stigma is the denuded, secreting, humid apex of the midrib.

359. Where the margins of the folded leaf, out of which the carpel is formed, meet and unite, a copious development of cellular tissue takes place, forming what is called the *placenta*.

360. Every placenta is therefore composed of two parts, one of which belongs to one margin of the carpel, and one to the other.

361. As the carpels are modified leaves, they necessarily obey the laws of arrangement of leaves, and are therefore developed round a common axis.

362. And as they are leaves folded inwards, their margins are necessarily turned towards the axis. The placenta, therefore, being formed by the union of those margins, will be invariably next the axis.

363. So that if a whorl of several carpels unite and constitute a pistil, the placenta of that pistil will be all in the axis.

364. The normal position of the carpels is alternate with the innermost row of stamens, to which they are also equal in number; but this symmetry of arrangement is constantly destroyed by the abortion or non-development of part of the carpels.

365. The carpels often occupy several whorls, in which case they are usually distinct from each other; *Ex.* Ranunculus, Fragaria, Rosa.

366. Sometimes, notwithstanding their occupying more than one whorl, they all unite in a single pistil; *Ex.* Nicotiana multivalvis, Monstrous Citrons. In these cases the placenta of the innermost whorl of carpels occupy the axis, while those of the exterior carpels are united with the backs of the inner ones, as must necessarily happen in consequence of the invariable direction of the placenta towards the axis.

367. When the carpels are arranged round a convex receptacle (263.), the exterior ones will be lowest; *Ex.* Fragaria.

368. But if they occupy the surface of a tube, or are placed upon a concave receptacle, the exterior ones will be uppermost; *Ex.* Rosa.

369. This law will explain the structure of some anomalous pistils in which the carpels are united into a confused mass; *Ex.* the Pomegranate.

370. Notwithstanding the formation of the placenta out of the two united margins of a leaf, it often does not indicate any trace of such an origin; but, in consequence of non-developement, is sometimes reduced to a single point, bearing a single ovule.

371. When the placentiferous margin is fully and regularly developed, it occupies a line running down the inside of the cavity of a carpel, and bears two distinct rows of ovules.

372. If that part of the margin which is placentiferous is so small as to bear but a very few ovules at or towards the upper part of the line of union, the ovules will hang downwards within the cavity of the carpel, and be either *pendulous* or *suspended*.

373. And if the placentiferous part of the margin be only at the lower part of the line of union, the ovules will take a direction upwards into the cavity, and be either *erect* or *ascending*.

374. Whenever two carpels are developed, they are invariably opposite each other, and never side by side. This happens in consequence of the law of alternate opposition of leaves (160.).

375. When carpels unite, those parts of their sides which are contiguous grow together, and form partitions between the cavities of the carpels.

376. These partitions are called *dissepiments*.

377. Each dissepiment is therefore formed of two layers. But these often grow together so intimately as to form but one layer.

378. Such being the origin of the dissepiments, it follows that,

378. *a.* All dissepiments are vertical, and never horizontal.

378. *b.* They are uniformly equal in number to the carpels out of which the pistil is formed.

378. *c.* They proceed directly from the placenta.

378. *d.* They are alternate with placenta formed by the cohesion of the margins of the same carpel, and opposite placenta formed by the cohesion of the contiguous margins of different carpels.

378. *e.* A single carpel can have no dissepiment whatever.

379. It will also be apparent, that as the stigma must bear the same relation to the dissepiments as the point of the leaf to the sides of the lamina, the stigma will always be alternate with (between) the dissepiments.

380. When the dissepiments of a many-celled pistil are contracted so as not to separate the cavity into a number of distinct cells, but merely project into a cavity, the placenta, which occupy the edges of these dissepiments, become what is called *parietal*; *Ex.* Poppy.

381. If the dissepiments of a many-celled pistil are abortive or obliterated, the placenta remaining unaltered in the axis, a free central placenta is formed.

382. A one-celled ovary may also be formed out of several carpels, in consequence of the obliteration of dissepiments; *Ex.* Nut.

383. All dissepiments whose position is at variance with the foregoing laws are spurious.

384. *Spurious dissepiments* derive their origin from various causes, and may have either a vertical or horizontal position.

385. When they are horizontal they are called *phragmata*, and are formed by the distension of the placenta; *Ex.* Cathartocarpus Fistula.

386. If vertical, they either are projections from the back of the carpel, as in Amelanchier and Thespesia; or they are caused by modifications of the placenta, as in Martynia, Didymocarpus, and Cruciferae.

387. Sometimes the growing point or apex of the pedicel extends beyond the base of the carpels, rising up between them, and either forming an adhesion with the styles, as in Geranium, or a central distinct axis, as in Euphorbia.

388. This elongation of the apex of the pedicel is more apparent in the fruit than in the pistil. It is analogous to the cellular apex of the spadix (259.) of Arum.

389. The styles of different carpels frequently grow together into a solid cylinder; *Ex.* Lilium. There are various degrees of union between the styles.

390. The style is incorrectly said to be divided in different ways, in consequence of this adhesion.

391. If the *ovary* adheres to the sides of the calyx it is called *inferior*, and the *calyx* is said to be *superior*; *Ex.* Apple.

392. If it contracts no adhesion with the sides of the calyx it is called *superior*, and the *calyx* *inferior*.

XV. OVULE.

393. The OVULE is a body borne by the placenta (359.), and destined to become a seed (469.).

394. It is to the carpel (353.) what the marginal buds are to leaves (154.).

395. It does not, however, appear to bear any other analogy to a bud than what is indicated by its position.

396. The ovule is usually enclosed within an ovary (344); but in Coniferae and Cycadeae it is destitute of any covering, and is exposed, naked, to the influence of the pollen.

397. It is either sessile, or attached by a little stalk called the *funiculus*, or *podosperm*. The point of union of the funiculus and ovule is the *base* of the latter, and the opposite extremity is its *apex*.

398. It consists of two sacs, one enclosed within the other, and of a *nucleus* within the sacs.

399. These sacs are called the *primine* and *secundine*.

400. The primine, secundine, and nucleus, are all connected with each other by a perfect continuity of tissue, at some point of their surface.

401. When the parts of the ovule undergo no alteration of position during their growth, the two sacs and the nucleus are all connected at the base (397.) of the ovule.

402. And then the base of the nucleus and that of the ovule are in immediate connection with each other.

403. But the relative position of the sacs and the base of the ovule are often entirely altered during the growth of the latter, so that it frequently happens that the point of union of the sacs and the nucleus is at the apex (397.) of the ovule.

404. And then the base of the nucleus is at the apex of the ovule.

405. In such cases, a vascular connection is maintained between the base of the ovule and the base of the nucleus, by means of a bundle of vessels called a *raphe*.

406. The normal position of this raphe is on the side of the ovule, next the placenta.

407. The expansion of the raphe, where it communicates with the base of the nucleus, gives rise to the part of the seed called the *chalaza* (491.).

408. The mouths of the primine and secundine usually contract into a small aperture called the *foramen* of the ovule, or the *exostome*.

409. The apex of the nucleus is always applied to this foramen.

410. In consequence of the relation the base of the nucleus bears to the base of the ovule, the foramen will be at the apex of the ovule when the two bases correspond, and at the base of the ovule when the two bases are diametrically opposite.

411. It is through this foramen that the impregnating molecules of the pollen are introduced into the nucleus (332.).

412. The foramen indicates the future position of the radicle of the embryo (492.); the radicle being always next the foramen. This is a fact of great importance in practical Botany.

413. From some recent observations, it appears that the nucleus itself has three coats ; the outer called the *tercine*, the next the *quartine*, and the most interior the *quintine*.

414. But these are not always distinguishable, and part of them is usually absorbed during the advance of the ovule to the state of a seed.

415. The tercine and quartine are finally converted into albumen (494.), in consequence of their cells being gradually filled with a solid deposit which varies in nature in different species : the quintine becomes the *sac of the embryo* (501.), whenever that sac is distinguishable ; *Ex. Nymphæa*.

416. The nucleus contains a pulpy mass called the *liquor amnios*, which is supposed to be the substance from which the embryo absorbs its nutriment during its growth.

XVI. FRUIT.

417. The **FRUIT**, in the strictest sense of the word, is the pistil arrived at maturity. But the term is also applied to the pistil and floral envelopes taken together, whenever they are all united in one uniform mass.

418. Hence, whatever is the structure of the pistil, the same should be the structure of the fruit.

419. But in the course of the advance of the pistil towards maturity, many alterations take place, in consequence of abortion, non-development, obliteration, and union of parts.

420. Whenever the fruit contains any thing at variance with the laws that govern the structure of the pistil, the latter should be examined for the purpose of elucidation.

421. Sometimes a pistil with several cells produces a fruit with but one; *Ex.* the Hazel-nut and Cocoa-nut. This arises from the obliteration of part of the cells.

422. Or a pistil, consisting of one or two cells, changes to a fruit having several: the cause of this is a division and doubling of the placentary divisions; *Ex.* *Martynia*: or the expansion of portions of the placenta; *Ex.* *Cathartocarpus Fistula*.

423. As the fruit is the maturation of the pistil, it ought to indicate upon its surface some traces of a style; and this is true in all cases, except *Cycadææ* and *Coniferæ*, which have no ovary.

424. Hence the grains of corn, and many other bodies that resemble seeds, having traces of the remains of a style, cannot be seeds, but are minute fruits.

425. That part which was the ovary in the pistil, becomes the pericarp in the fruit.

426. The PERICARP consists of three parts, the outer coating called the *epicarp*, the inner lining called the *endocarp*, or *putamen*, and the intermediate substance named the *sarcocarp*.

427. Sometimes these three parts are all readily distinguished; *Ex.* the Peach: frequently they form one uniform substance; *Ex.* a Nut.

428. The *base* of the fruit is the part where it is joined to the peduncle. The *apex* is where the remains of the style are found.

429. The axis of the fruit is often called the *columella*; the space where two carpels unite is named the *commis sure*.

430. All fruits which are mere modifications of a single carpellary leaf (354.) have always a suture corresponding with the junction of the margins, or with the placenta, and often another corresponding with the midrib of the carpellary leaf: the former is called the *ventral*, the latter the *dorsal suture*.

431. If the pericarp neither splits nor opens when ripe, it is said to be *indehiscent*; if it does split or open, it is said to *dehisc*, or to be *dehiscent*; and the pieces into which it splits are called the *valves*.

432. The dehiscence of the pericarp takes place in different ways.

433. If it takes place longitudinally, or vertically, so that the line of dehiscence corresponds with the junction of the carpels, the dissepiments are divided, the cells remain closed at the back, and the dehiscence is called *scepticidal*; *Ex.* *Rhododendron*.

434. Formerly, botanists said that in this kind of dehiscence the valves were alternate with the dissepiment; or, that the valves had their margins turned inwards.

435. If it takes place vertically, so that the line of dehiscence corresponds with the dorsal suture (430.), the dissepiments remain

united, the cells are opened at their back, and the dehiscence is called *loculicidal*; *Ex.* Lilac, Lily.

436. Formerly, it was said that in this kind of dehiscence *the dissepiments were opposite the valves*.

437. When a separation in the pericarp takes place across the cells horizontally, the dehiscence is *transverse*; *Ex.* Anagallis.

438. If the dehiscence is effected by partial openings of the pericarp, it is said to take place by pores; *Ex.* Poppy.

439. Sometimes the cells remain closed, separating from the axis, formed by the extension of the peduncle (387.); *Ex.* Umbelliferæ, Euphorbia.

440. Or the cells open and separate from the axis, which is formed by a cohesion of the placentæ which separate from the dissepiments; *Ex.* Rhododendron.

441. Sometimes the dissepiments cohere at the axis, and separate from the valves (431.) or back of the carpels; *Ex.* Convolvulus.

442. All fruits are either *simple* or *multiple*.

443. Simple fruits proceed from a single flower; *Ex.* Pæony, Apple, Nut, Strawberry.

444. Multiple fruits are formed out of several flowers; *Ex.* Fir, Pine-Apple, Fig. They are masses of inflorescence in a state of adhesion, and are also called *anthocarpous*.

445. Simple fruits are either the maturation of a single carpel (354), or of a pistil formed by the union of several carpels (363.)

446. Of fruits formed of a single carpel, the most important are the Follicle (447.), Legume (448.), Drupe (451.), Akenium (452.), Caryopsis (454.), and Utricle (455.).

447. The *Follicle* is a carpel dehiscing by the ventral suture, and having no dorsal suture; *Ex.* Pæony.

448. The *Legume* is a carpel having both a ventral and dorsal suture, and dehiscing by both, either, or neither; *Ex.* Pea.

449. The two sutures of a legume sometimes form what is called a *replum*; *Ex.* Carmichælia.

450. When articulations take place across the legume, and it falls into several pieces, it is said to be *lomentaceous*; *Ex.* Ornithopus.

451. The *Drupe* differs from the follicle in being indehiscent, and in its pericarp having a distinct separation of epicarp (426.), sarcocarp, and endocarp; *Ex.* a Peach.

452. The *Akenium* is an indehiscent, bony, one-seeded pericarp, which does not contract any degree of adhesion with the integument of the seed; *Ex.* Strawberry.

453. It is a drupe, the pericarp of which does not separate into three layers.

454. The *Caryopsis* is an indehiscent, membranous, one-seeded pericarp, which adheres firmly to the integument of the seed; *Ex.* Corn.

455. The *Utricle* is a caryopsis, the pericarp of which has no adhesion with the integuments of the seed; *Ex.* Eleusine, Chenopodium.

456. Of fruit formed of several carpels, the principal are the

Capsule (457.), Siliqua (458.), Nut or Gland (460.), Berry (461.), Orange (462.), Pome (463.), and Pepo (464.).

457. The *Capsule* is a many-celled, dry, dehiscent pericarp; *Ex.* Poppy, Lychnis.

458. The *Siliqua* consists of two (or four?) carpels fastened together, the placentæ of which are parietal, and separate from the valves, remaining in the form of a replum (449.), and connected by a membranous expansion; *Ex.* Brassica.

459. When the siliqua is very short, or broader than it is long, it is called a *Silicula*.

460. The *Nut* or *Gland* is a dry, bony, indehiscent, one-celled fruit, proceeding from a pistil of three cells, and enclosed in an involucre called a *Cupule*; *Ex.* the Hazel, Acorn. It is a sort of compound achenium.

461. The *Berry* is a succulent fruit, the seeds of which lose their adhesion when ripe, and lie loose in pulp; *Ex.* a Gooseberry, a Grape.

462. The *Orange* is a berry having a pericarp separable into an epicarp, an endocarp, and a sarcocarp, and the cells filled with pulpy bags, which are cellular extensions of the sides of the cavity.

463. The *Pome* is a union of two or more inferior carpels, the the pericarp being fleshy, and formed of the floral envelope and ovary firmly united; *Ex.* an Apple.

464. The *Pepo* is composed of about three carpels, the sides of which do not turn far inwards, nor the margins unite. It is a one-celled, fleshy, indehiscent fruit, with parietal placentæ; *Ex.* Cucumber.

465. The most remarkable modifications of multiple or anthocarpous fruits are, the Cone (466.), Pine-Apple (467.), and Fig (468.).

466. The *Cone* is an indurated amentum (260.); *Ex.* Pinus. When it is much reduced in size, and its scales firmly cohere, it is called a *Galbulus*; *Ex.* Thuja.

467. The *Pine-Apple* is a spike of inferior flowers, which all grow together into a fleshy mass.

468. The *Fig* is the fleshy, hollow, dilated apex of a peduncle, within which a number of flowers are arranged, each of which contains an achenium.

XVII. SEED.

469. The *SEED* is the ovule (393.) arrived at maturity.

470. It consists of integuments (482.), albumen (494.), and embryo (520.), and is the result of the reciprocal action of the sexual apparatus.

471. As all seeds are matured ovules, and as ovules are originally enclosed within an ovary, it is obvious that *naked seeds* cannot exist.

472. Cycadææ and Coniferæ are the only exceptions to this (396.).

473. But some ovules rupture the ovary soon after they begin to advance towards the state of seed, and thus become naked

seeds; *Ex.* Leontice. Others are imperfectly protected by the ovary, the carpels not being perfectly closed up; *Ex.* Reseda.

474. The seed proceeds from the placenta (359.), to which it is attached by the funiculus (397.).

475. Sometimes the funiculus, or the placenta, expands about the seed into a fleshy body; *Ex.* the *Mace* of a nutmeg, *Euonymus*. This expansion is named *aril*.

476. It is never developed until after the vivification of the ovule, and must not be confounded with tumours or dilatations of the integument of the seed.

477. Sometimes there are tumours of the testa near the hilum or at the opposite end; such are called *Strophiole* or *Caruncula*.

478. The precise nature of these is unknown; sometimes they are dilatations of the chalaza; *Ex.* Crocus: or they are caused by a fungus state of the lips of the foramen; *Ex.* Ricinus: or they arise from unknown causes.

479. The scar, which indicates the union of the seed with the placenta, is called the *hilum* or *umbilicus*.

480. The hilum represents the *base* of the seed. The *apex* is determined by the point where the vessels or tissue of the integuments concentrate.

481. Hence, in curved seeds the apex and base are frequently contiguous; *Ex.* Mignonette.

482. The integuments are called collectively *testa*, and consist of membranes, resulting from the sacs of the ovule (399.).

483. Sometimes the testa is covered by hair-like expansions of its whole surface; as in the Cotton; or these hairs occupy one or both ends, when they constitute what is called the *coma*. This must not be confounded with pappus (283.).

484. Some of these occasionally grow together, so that seeds are sometimes apparently enclosed in but one or two membranes.

485. In the seed these membranes are called by various names, of which the most frequently used are *spermoderm* or *testa* for the primine; *mesosperm*, for the secundine; and *endopleura* for the other.

486. All that existed in the sacs of the embryo is to be found in the integuments of the seed, but in a more developed state.

487. The mouth of the foramen (408.) is often distinctly visible, and is named the *micropyle*; *Ex.* Pea.

488. The *raphe* (405.) occupies one side of the seed in all cases in which it pre-existed in the primine; but it frequently becomes much ramified.

489. The *raphe* is in no way connected with impregnation; its functions being apparently confined to maintaining a vascular connection between the placenta and the base of the nucleus, for the purpose of nourishing the latter.

490. Spiral vessels are found in the *raphe* and its ramifications.

491. Where vessels of the *raphe* expand into the mesosperm (485.), the *chalaza* (407.) appears as a discoloured thickening of the integuments.

492. The micropyle always indicates the point in the circumference of a seed towards which the radicle (412.) points.

493. And the chalaza is as constant an indication, when it is present, of the situation of the cotyledons (503.); it being always at that part of the circumference organically opposed to the radicle.

494. Between the integuments and the embryo of some plants lies a substance called the *albumen* or *perisperm*.

495. It consists of a peculiar matter deposited during the growth of the ovule among the cellular tissue of the nucleus (398. 415.).

496. Care must be taken not to confound a thickening of the endopleura (485.) with the real albumen; *Ex.* Cathartocarpus Fistula. It is probable that this is often done by botanists, especially in regard to plants belonging to tribes usually destitute of albumen.

497. When the cellular tissue of the nucleus combines with the deposited matter so completely as to form together but one substance, the albumen is called solid; *Ex.* Wheat, Euphorbia. When a portion of the tissue remains unconverted, the albumen is *ruminated*; *Ex.* Anona, Nutmeg.

498. Albumen is usually wholesome, and may be frequently eaten with impunity in the most dangerous tribes; *Ex.* Euphorbiaceæ.

499. The organised body that lies within the seed, and for the purpose of protecting and nourishing which the seed was created, is the *Embryo*.

500. The embryo was originally included within the most interior membrane of the ovule.

501. The latter is usually absorbed or obliterated during the advance of the embryo to maturity; but it sometimes remains surrounding the ripe embryo, in the form of a sac, which is called *Vitellus*; *Ex.* Saururus, Piper.

502. The embryo consists of the cotyledons (503.), the radicle (505.), the plumule (504.), and the neck (506.).

503. The *cotyledons* represent undeveloped leaves.

504. The *plumule*, or *gemmule*, is the nascent ascending axis (60.).

505. The *radicle* is the rudiment of the descending axis (60.).

506. The *neck* (Collet, *Fr.*) is the line of separation between the radicle and the cotyledons.

507. The space that intervenes between the neck and the base of the cotyledons is called the *cauliculus* (Tigelle, *Fr.*)

508. The embryo is usually solitary in the seed, but occasionally there are two or several (334.).

509. When several embryos are produced within a single seed, it sometimes happens that two of these embryos grow together, in which case a production analogous to animal dicephalous monsters is formed.

510. The number of cotyledons varies from one to several. The most common number is either one or two. In the latter case, they are always directly opposite each other.

511. Plants that have but one cotyledon, or if two, then the cotyledons alternate with each other, are called **MONOCOTYLEDONOUS**.

512. Plants that have two opposite each other, or a greater number placed in a whorl, are called **DICOTYLEDONOUS**.

513. Endogenous plants are monocotyledonous.

514. Exogenous plants are dicotyledonous.

515. Plants that have no cotyledons are said to be **ACOTYLEDONOUS**.

515. *a.* But this term is usually applied only to cellular plants which, having no sexual apparatus, can have no seeds (470. 393.).

515. *b.* Acrogenous plants are acotyledonous.

515. *c.* Those seeds of flowering plants, which appear to have no cotyledons, owe their appearance to the cotyledons being consolidated; *Ex.* *Lecythis*, *Olynthia*: or abortive; *Ex.* *Cuscuta*.

516. The plumule is very often latent, until it is called into action by the germination of the seed. Sometimes it is undistinguishable from the cotyledons; sometimes it is highly developed, and lies in a furrow of the cotyledon; *Ex.* Maize. In the monocotyledonous embryo it frequently happens that the plumule is rolled up in the cotyledon, the margins of which grow together, so that the whole embryo forms one uniform mass; but as soon as germination commences the margins separate.

517. The radicle elongates downwards, either directly from the base of the embryo, or after previously rupturing the integument of the base. Plants with the first character are called **EXORHIZÆ**; with the second, **ENDORHIZÆ**.

518. The endorhizal embryo is very common in monocotyledons; the exorhizal, in dicotyledons.

519. The direction of the embryo, with respect to the seed, will depend upon the relation that the integuments, the raphe, chalaza, hilum, and micropyle, bear to each other.

520. If the nucleus be inverted, the embryo will be erect, or *orthotropous*; *Ex.* Apple.

521. If the nucleus be erect, the embryo will be inverted, or *antitropous*; *Ex.* Nettle.

522. If the micropyle is at neither end of the seed, the embryo will be neither erect nor inverted, but will be in a more or less oblique direction with respect to the seed; *Ex.* Primrose; and is said to be *heterotropous*.

523. When the seed is called into action, germination takes place. The juices of the plant, which before were insipid, immediately afterwards abound with sugar; *Ex.* Barley; and growth commences.

524. This growth is in the first instance caused by the absorption of water and oxygen by the seed, and by the expulsion, by the cotyledons, of superfluous carbon, in the form of carbonic acid gas.

524. *a.* As this phenomenon does not take place in full-grown plants, except in the dark (218.), so neither can it occur in seeds, except under the same condition. Hence an embryo, exposed to

constant light, would not germinate at all; and hence the care taken by nature to provide a covering to all embryos in the form of the integuments of the seed or of a pericarp.

524. *b.* As soon as the necessary proportion of carbon is removed from a seed by the expulsion of carbonic acid, the young plant begins to absorb the latter, and to grow by the alternate composition and decomposition of carbonic acid (220.).

XVIII. ACROGENS, OR FLOWERLESS PLANTS.

525. Many plants not being increased by seeds, the result of the mutual action of sexual apparatus (470.), are flowerless, and destitute of organs of fructification.

526. Such are propagated by what are called organs of reproduction, which have no other analogy with the organs of fructification than that both perpetuate the species.

527. The reproductive organs of flowerless plants vary according to the tribes of that division of the vegetable kingdom, and have so little relation to each other, that each principal tribe may be said to have its own peculiar method of propagation.

527 *a.* They all, however, agree in their reproductive parts, which are analogous to seeds not germinating from any fixed point, but producing root or stem indifferently from any point of their surface. This germination is therefore *vague*.

528. The principal tribes are *Ferns* (529.), *Mosses* (535.), *Lichens* (541), *Algæ* (542.), and *Fungi* (543.).

529. *FERNS* are increased by little bodies called *sporules*, enclosed within cases named *thecæ*, which often grow in clusters or *sori*, from the veins of the under sides of the leaves, or from beneath the cuticle. The latter, when it encloses the *thecæ*, is termed the *indusium*.

530. The *indusium* separates from the leaf in various ways, in consequence of the growth of the *thecæ* beneath it.

531. The *thecæ* have frequently a stalk which passes up one side, and finally, curving with their curvature, disappears on the opposite side.

532. The part where the stalk of the *theca* is united with its side is called the *annulus*.

533. These *thecæ* may be considered minute leaves, having the same gyrate mode of developement as the ordinary leaves of the tribe; their stalk the petiole, the annulus the midrib, and the *thecæ* itself the lamina, the edges of which are united.

534. They would therefore be analogous to carpels, if it appeared that they were influenced by the action of any vivifying matter.

535. *MOSSES* are increased by *sporules* (529.), contained within an *urn* or *theca*, placed at the apex of a stalk or *seta*, bearing on its summit a kind of loose hood, called a *calyptra*, and closed by a lid or *operculum*.

536. The inside of the *theca* has a central axis or *columella*, and the orifice beneath the *operculum* is closed by teeth-like processes, or a membrane, called the *peristome*.

537. The number of the teeth of the peristome is always some multiple of four.

538. The calyptra originally grew from the base of the stalk; but when the stalk lengthened, the calyptra was torn away from its base and carried up, surrounding the theca.

539. The calyptra may be understood to be a convolute leaf; the operculum, another; the peristome, one or more whorls of minute flat leaves; and the theca itself to be the excavated distended apex of the stalk, the cellular substance of which separates in the form of sporules.

540. There are also in mosses organs, called anthers by some, which do not appear analogous to the male apparatus of flowering plants, and the nature of which has not been demonstrated.

541. LICHENS are propagated by sporules, included within little membranous cases, which lie within a denuded portion of their own central substance, called the *scutellum*, *apothecium*, or *shield*.

542. ALGÆ increase by sporules, which are usually formed by a separation of cellular tissue, within the substance of the plants themselves.

543. FUNGI have a similar mode of propagation. In some of the most highly developed of the order, the part in which the sporules lie is distinct in appearance from the rest, and called the *hymenium*.

XIX. SYSTEMS.

544. Systematic Botany is the science of arranging plants in such a manner that their names may be ascertained, their affinities determined, their true place in a natural system fixed, their sensible properties judged of, and their whole history elucidated with certainty and accuracy.

545. Any thing short of this is not a system, but an artificial scheme.

546. The latter is intended to enable a person to ascertain the name of a plant and goes no further.

547. But as the name of a plant conveys no information by itself, the power thus acquired by artificial schemes is of but little real value, and cannot be considered as any thing beyond a very imperfect and elementary mode of investigation.

548. What knowledge is gained by the use of an artificial scheme, is a mere collection of isolated facts, without mutual dependence, or any distinct bearing upon general views.

549. In a natural arrangement, on the other hand, the name of a plant is the least object that is gained. Any investigation upon its principles, when completed, is, of necessity, attended with the discovery of the relationship a given plant bears to others; and as plants which are most closely akin in structure, are also most similar in their sensible properties, it enables us to judge of the use of an unknown plant whose place is determined in the system, by the ascertained uses of those species in whose vicinity it takes its place by virtue of its natural affinities.

550. The characters by which natural affinities are ascertained, are valuable in proportion to their importance to the existence of a plant.

551. For this reason, the axis and leaves, without which plants could not exist, are of the first importance.

552. Flowers and fruit, without which they could not be multiplied, are of the next degree of value.

553. Accidental circumstances, not essential either to nutrition or reproduction, are of inferior consequence.

554. It is, however, extremely difficult, when we enter into the details of the value of characters, to comprehend what gives some of the subordinate peculiarities of plants the value we assign to them. No fixed rule has yet been discovered for judging of this; and consequently the employment of secondary characters is in a great degree arbitrary.

555. Hence, a character which is valuable in one class of plants, appears worthless in another.

556. Hence also, a considerable diversity of opinion among botanists as to the true principles upon which a natural system is to be worked out in all its details.

557. Botanists are, however, nearly agreed upon the primary classes and ultimate groups or natural orders; and only dispute about the intermediate divisions.

558. The fundamental principle of systematic botany is, that those plants should be stationed in company with each other which have the greatest degree of affinity; and that those should be placed most remotely which have the smallest degree of affinity.

559. Affinity is an accordance in all essential characters.

560. From this is distinguished analogy, which is a conformity in one or two characters only.

561. What we call the characters of plants are merely the signs by which we judge of affinity, and all the groups into which plants are thrown are in one sense artificial, inasmuch as nature recognises no such groups.

562. Nevertheless, consisting in all cases of species very closely allied in nature, they are in another sense natural.

563. But as the classes, subclasses, groups, alliances, natural orders and genera of botanists have no real existence in nature, it follows that they have no fixed limits, and consequently that it is impossible to define them.

564. They are to be considered as nothing more than the expression of particular *tendencies* (*nixus*) on the part of the plants they comprehend, to assume a particular mode of development.

565. Their characters are therefore nothing more than a declaration of their prevailing tendencies; and are liable to numerous exceptions.

566. This liability, it must be remarked, exists as much in all artificial schemes as in the natural system itself.

XX. LINNEAN ARTIFICIAL SCHEME.

567. This is now disused by men of science; but, as many books still employed have been arranged upon its plan, it is necessary for a student to understand it.

568. Its divisions depend upon modifications of the stamens and pistils, and have Greek names expressive of their distinctive characters.

CLASS	1. Monandria		ORDERS.
	2. Diandria	}	<i>Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Hexagynia, Heptagynia, Octogynia, Enneagynia, Decagynia, Dodecagynia, Polygynia.</i>
	3. Triandria		
	4. Tetrandria		
	5. Pentandria		
	6. Hexandria		
	7. Heptandria		
	8. Octandria		
	9. Enneandria		
	10. Decandria		
	11. Dodecandria		
	12. Icosandria		
	13. Polyandria		
	14. Didynamia	}	<i>Gymnospermia, Angiospermia.</i>
	15. Tetradynamia		
	16. Monadelphia	}	<i>Siliculosæ, Siliculosæ.</i>
	17. Diadelphia		
	18. Polyadelphia		
	19. Syngenesia	.	<i>Polygamia æqualis, superflua, frutranæa, necessaria, segregata, Monogamia.</i>
	20. Gynandria	}	<i>Monandria, Diandria, &c.</i>
	21. Monœcia		
	22. Diœcia		
	23. Polygamia		
	24. Cryptogamia	.	<i>Monœcia, Diœcia.</i>
		.	<i>Filices, Musci, Hepaticæ, Algæ, Fungi.*</i>

XXI. THE NATURAL SYSTEM.

569. The Natural System consists of species disposed in genera, genera in orders, orders in alliances, alliances in groups, groups in subclasses, subclasses in classes.

570. The genera, orders, and classes may be considered as agreed upon by botanists. The other divisions are unsettled.

571. Hence the natural orders seldom follow in the same manner in the arrangements of two different botanists.

572. There is no such thing as an arrangement which shall express the natural relations of plants in a consecutive series.

* This list is given merely as a memorandum by which a student may accompany his professor in the lecture-room. The scheme is not worth any further place or notice.

573. For the affinity of plants may be compared to rays drawn from the centre of a sphere, which spread in all directions, and impinge upon the affinities of other spheres in their neighbourhood.

574. For this reason all attempts at discovering a lineal arrangement are chimerical.

575. This being an established truth, botanists are generally satisfied with collecting their natural orders in a manner confessedly artificial, without troubling themselves to establish natural groupes intermediate between the primary classes and the orders themselves.

576. This gives an appearance of confusion to the system, and has moreover the disadvantage of making the analysis of the orders excessively complicated and difficult.

577. Nevertheless it is plain that there do exist subordinate groupes intermediate between the classes and orders, which are equally natural with the latter; and it is certain that if their limits could be tolerably defined, and their real characters ascertained with some precision, a great step would be made towards the perfecting of the system.

578. In the absence of any better distribution, I employ the following, in which I have endeavoured to work out the axiom of Fries, that every division (or sphere) indicates some one single idea, and that hence the character of each division is best expressed by some simple notion.

579. It has not, however, been possible to attain absolute simplicity, and there is no doubt that the true character of a large number of groups and alliances still remains to be ascertained.

580. To prevent confusion in the use of the names of the numerous divisions in the natural system, it is to be observed, that the names of the suborders terminate in *æ*, of the orders in *aceæ*, of the alliances* in *ales*, and of the groups in *osæ*. The higher divisions have merely plural terminations.

581. The ear of the classical critic may be offended at many of these terminations, but the distinction which they establish is too important not to outweigh all verbal niceties of construction.

* For the suggestion of this very expressive name, I am indebted to Sir Edward Ffrench Bromhead, Bart., who has long been occupied in the investigation of the natural affinities of the vegetable kingdom.

THE ALLIANCES OF PLANTS.

CLASSES.

The whole vegetable kingdom is divisible into five principal classes, which may be characterised as follows : —

Propagated by sexes	{	having spiral vessels	{	Exogens (80.) with their seeds in an ovary	I. EXOGENÆ.
		without spiral vessels, or with scarcely any	{	Exogens with naked seeds	II. GYMNOSPERMÆ.
				Endogens (80.)	III. ENDOGENÆ.
					IV. RHIZANTHÆÆ.
Propagated without sexes					V. ACROGENÆ.

They are further known by a separate consideration of the nature of all their principal organs thus : —

	Tissue.	Wood.	Veins of Leaves.	Floral Envelopes.	Sexes.	Embryo.	Germination.
I. EXOGENÆ	Vascular	Exogens	Netted	Quinary	Perfect	Dicotyledonous	Exorhizal (517.).
II. GYMNOSPERMÆ	Imperfectly do.	Exogens	Parallel or forked		Imperfect	Dicotyledonous	Exorhizal.
III. ENDOGENÆ	Vascular	Endogens	Parallel	Ternary	Perfect	Monocotyledonous	Endorhizal (517.).
VI. RHIZANTHÆÆ	Cellular			Variable	Imperfect	Acotyledonous	Unknown.
V. ACROGENÆ	Cellular	Acrogens	Forked, or 0	Absent	Absent	Acotyledonous	Vague (527.a).

The five classes form a circle, the centre of whose circumference is occupied by Exogens and Endogens, the common point by Acrogens, and the intermediate spaces by Gymnospermæ and Rhizanthææ, which are transition classes. This may be expressed thus : —

Exogens, Endogens,
Gymnospermæ, Rhizanthææ,
Acrogens.

This proposition is to be demonstrated in the course of the following explanation of the characters and affinities of the various Classes, Subclasses, Groups, Alliances, and Natural Orders of which the vegetable kingdom consists. (See p. 75.)

CLASS I. EXOGENÆ.

The Subclasses are

{ Complete Plants ; with both their calyx and corolla perfect ; or at least with the calyx highly developed, if the petals are absent ; these divide into

1. POLYPETALÆ, with the petals distinct.
2. INCOMPLETE plants; in which there is no corolla; their calyx is generally either but little developed or altogether absent.

No division of Exogens has been discovered more in accordance with natural affinities, than that which depends upon the different degree of development of the flower: it is true, indeed, that its characters are not always constant, and that practical difficulties arise from the circumstance of some genera belonging to polypetalous orders having no petals, while a portion of some monopetalous orders are actually polypetalous, and so on. Nevertheless the arrangement founded upon the distinctions above recorded appears to be natural, if the latter are rightly considered.

As understood by me, all those orders in which the floral envelopes are herbaceous, and imperfectly developed, belong to Incomplete, whether there are two rows or not, as Menispermaceæ; nor ought others, as Euphorbiaceæ, to be removed from Polypetalæ, because although the

mass of such orders is polypetalous, certain European genera, with which we are best acquainted, have no petals. With regard to those polypetalous orders, in some genera of which the petals cohere by their edges, so as to resemble a monopetalous corolla, the only means of recognising them is by observing that their petals are scarcely joined at the base; there is this, however, which assists in removing the difficulty: in true monopetalous orders the style is scarcely ever divided, except just at the point, and their fruit is therefore, in all cases, syncarpous; while, in those polypetalous genera, which take on a monopetalous appearance, the fruit is in reality apocarpous, as is the case with Anonaceæ, Crassulaceæ, Leguminaceæ, Meliaceæ, Diosmeæ, &c. The two latter, although syncarpous when young, yet become truly apocarpous as their fruit ripens.

SUBCLASS I. POLYPETALÆ.

These comprehend the following groups: —

1. ALBUMINOSÆ. Embryo very considerably shorter and smaller than the albumen.
2. EPIGYNOSÆ. Ovary inferior, usually having an epigynous disk.
3. PARIETOSÆ. Placentæ parietal.
4. CALYCOSÆ. Calyx incompletely whorled; two of the sepals being exterior.
5. SYNCARPOSÆ. None of the characters of the other groups, and with the carpels compactly united.

6. GYNOBASEOSÆ. Carpels not exceeding five, diverging at the base, arranged in a single row around an elevated axis, or gynobase (§37. *b*). Stamens usually separate from the calyx (hypogynous * of authors).
7. APOCARPOSÆ. None of the characters of the other groups, but with the carpels distinct; or separable by their faces; or solitary.

N. B. In the succeeding pages the first column contains a brief character of the Natural Order; the second the name of the Order; the third its sensible properties, with some official example in italics within brackets, when any is to be found. When the third column is blank nothing is known of the sensible property.

The orders marked ㊦ (eighty-nine in number) are the most important, and those with which all students should be made acquainted.

GROUP I. ALBUMINOSÆ.

Alliance 1. *Ranales*. Herbaceous plants, either apocarpous † (355. *a*), or with parietal placentæ.

Floral envelopes in threes or fives.	Sap transparent	1. Ranunculaceæ ㊦	. . .	Acrid, poisonous (<i>Black Hel-</i> <i>leboræ, Aconite</i>).
Floral envelopes in twos or fours.	Sap usually	1. ♂ Podophylleæ	. . .	Cathartic.
milky	. . .	2. Papaveraceæ ㊦	. . .	Narcotic (<i>Poppy</i>).
Embryo enclosed in a vitellus.	Floaters . . .	2. ♂ Fumariæ ㊦	. . .	Diaphoretic and aperient.
		3. Nymphæaceæ	. . .	Slightly astringent.
		3. ♂ Hydropeltideæ.		
Ovaries concealed in a fleshy receptacle.	Floaters	4. Nelumbiaceæ	. . .	Wholesome.
Stamens perigynous . . .	. . .	5. Cephalotaceæ	<i>R. Br.</i>	
Polyspermous, with basal many-seeded placentæ . . .	? Dionææ.			

* It is to be remarked, that in this and the following characters, the term hypogynous is applied to all plants with a superior ovary, and the term epigynous to those with an inferior ovary. Therefore the term hypogynous is here equal to perigynous and hypogynous of other writers (313.).

† Apocarpous always means *single* carpels, as well as a collection of *separate* or *separable* ones.

Alliance 2. *Anonales*. Apocarpous woody plants.

Flowers unisexual, three-lobed.	6. Myristicaceæ . . .	. Acrid, aromatic (<i>Nutmeg</i>).
Leaves with stipules, without dots	7. Magnoliaceæ \mathfrak{B} . . .	. Bitter, tonic.
Leaves with stipules and transparent dots	8. Winteraceæ . . .	. Aromatic, stimulant (<i>Winter's Bark</i>).
Flowers hermaphrodite, three-parted.	9. Anonaceæ \mathfrak{B} . . .	. Aromatic (<i>Piper athiopicum</i>).
usually distinct	9. \S Schizandreeæ <i>Bl.</i>	
Leaves without stipules.	10. Dilleniaceæ . . .	. Astringent.

Alliance 3. *Umbellales*. Flowers epigynous (314.), arranged in umbels. Stems usually hollow.

Carpels two	11. Umbellaceæ \mathfrak{B} . . .	. Herb poisonous (<i>Hemlock</i>); sometimes stimulant and eatable (<i>Parsley, Parsnip</i>); fruit aromatic (<i>Anise</i>).
Carpels more than two	12. Araliaceæ . . .	. Slightly stimulant (<i>Ginseng</i>).

Alliance 4. *Grossales*. Flowers epigynous, arranged in racemes. Stems solid.

Placentæ parietal	13. Grossulaceæ \mathfrak{B} . . .	. Tonic, or harmless (<i>Black Currants</i>).
Placentæ central, many-seeded	14. Escalloniaceæ.	
Placentæ central, few-seeded	15. Bruniaceæ.	

Alliance 5. *Berberales*. Apocarpous, with the valves of the anthers curved backwards.

16. Berberaceæ \mathfrak{B} . . .	. Acid, astringent (<i>Berberry</i>). Dye yellow.
16 \S Nandineæ <i>m.</i> . .	

Alliance 6. *Pittosporales*. Syncarpous, with hypogynous stamens, and the placentæ in the centre of the fruit.

Fruit two-celled. Seeds few 17. Vitaceæ \mathfrak{B} Acidity and sugar (*Vine*).

Fruit with more than two cells. Seeds numerous.

Stamens all perfect

Petals split. Flowers unsymmetrical (293. b.) 18. Pittosporaceæ.

Fruit with more than two cells. Seeds numerous.

Stamens half sterile 19. Olacaceæ.

Stigma leafy, peltate 20. Francoaceæ.

Stigma leafy, peltate 21. Sarraceniaceæ.

A group in appearance truly natural, and agreeing with its technical character in all respects, with the exception of Nelumbium, which has no albumen; and the genus Berberis, in which the embryo is much larger in proportion to the albumen than in any other instance. Dionæa is a paradoxical plant, whose true affinities are doubtful. It appears most nearly allied to Ranunculaceæ, or Cephalotaceæ, and is perhaps analogous to the genus Adrastæa among Anonaceæ.

Some connecting links are obviously wanting in this group; and, until it is well considered, it will appear less natural than it really is, especially if we compare such plants as the Vine with the Crowfoot, or either with Sarracenia. Nevertheless, it is to be observed, that it very nearly agrees with De Candolle's Thalamiflorous subclass, and that the mutual affinities of the alliances may be demonstrated. Take Anonales and Ranales for the centre of the circumference of a circle composed of the six foregoing alliances : —

Then Anonales pass into Pittosporales through Cheiranthera ;
 Pittosporales — Grossales — Ribes;
 Grossales — Berberales — Berberis;
 Berberales — Umbellales — Nandineæ;
 Umbellales — Ranales — Thalictrum;
 Ranales — Anonales — Magnolia;
 and the relative position of the alliances will be thus : —

Anonales Ranales
 Pittosporales Umbellales
 Grossales Berberales.

There is no difficulty whatever in pointing out the various gradations that connect the genera belonging to the orders comprehended in the Albuminous group; but this is not the place for the discussion. The most paradoxical part of the combination is the union of baccate-fruited with dry-fruited plants: but even Vitaceæ pass into Umbellaceæ through Leea; and the petals of the genus Vitis itself are inflected at the points, in the way of Umbellaceæ.

GROUP II. EPIGYNOSÆ.

Alliance 1. *Onagrales*. Æstivation not valvate. Placentæ central. Every part of the flower some regular multiple of two.

22. Onagraceæ \mathfrak{B} None. Harmless.

22. § Circææ.
22. § Haloragææ . . . None.

Alliance 2. *Myrtales*. Æstivation not valvate. Placentæ central. Number of parts of the flower uncertain.

- Carpels single. Petals broad . . . 23. Combretacæ . . . Astringent (*Myrobalan*).
Carpels single. Petals very narrow . . . 24. Alangiaceæ . . . Hydragogues.
Stipules between the leaves . . . 25. Rhizophoracæ . . . Astringent (*Mangrove*).
Stamens bent downwards. Leaves one-ribbed . . . 26. Memecylacæ.
Stamens bent downwards. Leaves three- or more-ribbed . . . 27. Melastomacæ . . . Slightly astringent.
Leaves dotted, with an intramarginal vein . . . 28. Myrtacæ 29 . . . Aromatic, stimulant (*Cajeputi, Cloves*); bark astringent.
Leaves alternate. Flowers irregular . . . 29. Lecythacæ . . . Fruit eatable (*Brazil nut*).
Leaves not dotted. Stamens straight . . . 30. Philadelphacææ.

Alliance 3. *Cornales*. Æstivation of flowers valvate.

- Leaves with stipules . . . 31. Hamamelacæ.
Leaves without stipules . . . 32. Cornacæ 33 . . . Tonic.
Parasitical plants, bearing their stamens on their petals . . . 33. Loranthacæ . . . Astringent.

Alliance 4. *Cucurbitales*. Placentæ parietal.

- Flowers unisexual . . . 34. Cucurbitacæ . . . Purgative (*Colocynth*); often eatable (*Melon, Gourd*).
Flowers with a ring of abortive stamens . . . 35. Loasacæ . . . Stinging.
Petals extremely numerous . . . 36. Cactacæ . . . Subacid; wholesome.
Sepals and petals alike. Glands between the stamens 37. Homalinacææ.

Alliance 5. *Ficoidales*. Petals extremely narrow and numerous.

38. Ficoidaceæ * . Wholesome.

Alliance 6. *Begoniales*. Flowers unisexual. Placentæ central.

39. Begoniaceæ . Slightly astringent.

These plants seem to be all connected by a general natural relationship; and yet it is extremely difficult to fix the limits of their alliances. They appear to be connected with the syncarpous group through Melastoma and Lythraceæ, and with the albuminous group by the genus Eupomatia, and even by Cactaceæ, which evidently touch upon Grossulacæ. They also pass into Monopetalæ by Melastomaceæ, which join them with Gentianaceæ. I entertain no doubt about this being the true position of Begoniaceæ, among which we may expect to find some climbing species.

GROUP III. PARIETOSÆ.

Alliance 1. *Cruciales*. Embryo curved. Albumen absent.

Stamens tetradynamous	40. Cruciaceæ ¶	. Pungent, stimulant (<i>Mustard</i>).	49
Stamens indefinite	41. Capparidaceæ .	. Stimulant, sometimes poisonous.	
Fruit composed of three carpels	42. Resedaceæ . .	. None.	

Alliance 2. *Violales*. Stamens few, with no crown to the flower.

Leaves with stipules	43. Violaceæ ¶	. Roots emetic (<i>White Ipecacuanha</i>).
Leaves dotted	44. Samydaceæ.	
Fruit siliqueous	45. Moringaceæ .	. Pungent, aromatic.
Leaves circinate when young	46. Droseraceæ .	. Subacid.
Calyx ribbed	47. Frankeniaceæ.	

* As here understood, Ficoidaceæ consist of but a small portion of the genera usually referred thither.

Alliance 3. *Passionales*. Flowers with a ring or crown of sterile stamens. Petioles generally glandular.

Leaves with stipules	48. Passifloraceæ	• Subacid.
Flowers unisexual	49. Papayaceæ	• Vermifugal.
Placentæ spread over all the lining of the fruit	50. Flacourtiaceæ	• Suspicious.
	(51. Pangiaceæ <i>Blum.</i>).	
Stipules absent. Ovary stalked	52. Malesherbiaceæ,	
Stipules absent. Ovary sessile (Crown 0.)	53. Turneraceæ.	

Alliance 4. *Bixales*. Polyandrous. Leaves dotted.

54. Bixaceæ	• Purgative and stomachic (<i>Arnotto</i>).
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This is connected with the Epigynous group by Passiflora, and with the Calycose by Turnera, which passes into Cistaceæ. Otherwise its external relationships are not well marked. The orders themselves are very intimately related.

50

GROUP IV. CALYCOSÆ.

Alliance 1. *Guttates*. Polyandrous. Albumen absent. Petals equal in number to the sepals.

Leaves simple. Seeds few	55. Guttaceæ	• Fruit sometimes eatable (<i>Mangostan</i>); purgative, acid(<i>Gamboge</i>).
Leaves compound. Seeds few	56. Rhizobolaceæ	• Seeds eatable (<i>Sappocaya nuts</i>).
Leaves alternate. Flowers unsymmetrical. Seeds numerous	57. Marcgraaviaceæ.	
Styles several. Seeds numerous	58. Hypericaceæ	• Slightly purgative and febrile-fugal.

Alliance 2. *Theales*. Polyandrous, Albumen absent. Petals unequal to the sepals in number.

59. Ternströmiaceæ . Subnarcotic and astringent (*Tea*).

Alliance 3. *Acerales*. Stamens definite. Flowers unsymmetrical.

Petals without appendages. Fruit indehiscent,
winged, consisting of two carpels . 60. Aceraceæ . Saccharine (*Sugar maple*).
Petals having scales in front. Fruit indehiscent,
consisting of three carpels. A disk . 61. Sapindaceæ . Leaves and branches poisonous, fruit eatable (*Litchi*).

61. δ Millingtoniæ Arn.

Petals without appendages. Fruit dehiscent . 62. \mathcal{E} sculaceæ . Bark astringent, febrifugal (*Horsechestnut*).
Flowers papilionaceous 63. Polygalaceæ \mathcal{E} . Bitter, emetic, &c.
Flowers spurred 64. Vochyaceæ . Astringent (*Ratanhia root*).

Alliance 4. *Cistales*. Flowers regular. Albumen present.

Stamens equal to the number of sepals . 65. Elatinaceæ.
Decandrous, without stipules . . . 66. Linaceæ \mathcal{E} . Mucilaginous, tough (*Flax*).
Decandrous, with stipules 67. Hugoniaceæ.
Polyandrous, with an involucre . . . 68. Chlenaceæ.
Polyandrous. Style simple. Radicle remote from the hilum 69. Cistaceæ \mathcal{E} . Balsamic (*Labdanum*).
Polyandrous. Styles many. Seeds hairy . . 70. Reaumuriaceæ . Saline.

The characters of this group require careful consideration. Many gynobaseous plants have a calyx imbricated in a similar way, but they are removed by their gynobasic structure. The imbricated character of the calyx depends upon this: that the whorl of floral leaves is broken, so that about two of the sepals are out of the place of the others, and are, consequently, altogether external. The Calycose passes into the Parietose group by Turnera, and into the Syncarpous by Hugoniaceæ.

GROUP V. SYNCARPOSÆ.

Alliance 1. *Malvales*. Æstivation of calyx valvate; carpels four or more.

Stamens monadelphous.	Anthers two-celled	. 71. Sterculiaceæ	. Mucilaginous.
Stamens monadelphous.	Anthers one-celled	. 72. Malvaceæ ☞	. Mucilaginous (<i>Marsh mal-</i> <i>low</i>).
Anthers bursting by pores.	Petals lacerated	. 73. Elæocarpaceæ.	
Stamens monadelphous.	Calyx irregular and en-		
larged in the fruit	. . . . .	. 74. Dipteraceæ	. Resinous (<i>Camphor</i>).
Stamens distinct, separate from calyx	. . . . .	. 75. Tiliaceæ	. Mucilaginous.
Stamens distinct, growing on a tubular calyx	. . . . .	. 76. Lythraceæ ☞	. Astringent, acrid.

Alliance 2. *Meliales*. Æstivation of calyx imbricated; carpels four or more.

Stamens combined into a tube.	Seeds wingless	. 77. Meliaceæ	. Tonic and stimulant (<i>Ca-</i> <i>nella</i>).
Stamens somewhat monadelphous.	Seeds winged	. 78. Cedrelaceæ	. Ditto.
Stamens monadelphous, with a dilated connective	. 79. Humiriaceæ	. Balsamic.	
Leaves dotted. Fruit succulent	. . . . .	. 80. Aurantiaceæ ☞	. Subacid, fragrant (<i>Orange</i>).
Stamens growing to the calyx. Disk very large	. 81. Spondiaceæ	. Harmless.	

Alliance 3. *Rhamnales*. Æstivation of calyx valvate; carpels fewer than four.

Stamens opposite the petals	. . . . .	. 82. Rhamnaceæ ☞	. Dye (<i>French berries</i>); pur- gative (<i>Buckthorn</i>).
Stamens alternate with the petals	. . . . .	. 83. Chaillatiaceæ	. Poisonous.
Anthers opening by pores.	Seeds carunculate (477.)	. 84. Tremandraceæ.	
Somewhat polyandrous. Leaves succulent	. 85. Nitrariaceæ	. Saline.	
Secreting balsam	. . . . .	. 86. Burseraceæ	. Balsamic (<i>Balm of Gilead</i>).

Alliance 4. *Euphorbiales*. Estivation of calyx imbricated; carpels fewer than four.

Flowers unisexual.	Fruit triccous	. . . 87. Euphorbiaceæ	⚔	. Stimulant, purgative, poisonous (<i>Castor oil, cascavilla, &c.</i>).
Flowers hermaphrodite.	Petals united	. . . 88. Stackhousiaceæ.		
Seeds indefinite.	Petals united	. . . 89. Fouquieriaceæ.		
Flowers hermaphrodite.	Petals distinct	. . . 90. Celastraceæ.		
		. . . 90. ♂ Hippocrateæ		. Fruit sometimes eatable.
Leaves compound, with common and partial stipules		91. Staphyleaceæ	. . .	
Petals unguiculate.	Fruit winged	. . . 92. Malpighiaceæ	. . .	. Fruit sometimes eatable.
		. . . 92. ♂ Erythroxyleæ	. . .	. Dye red.

Alliance 5. *Silenales*. Embryo rolled round mealy albumen; or herbs with leaves having tumid joints.

Sepals two	. . . . .	. . . 93. Portulacææ	. . .	. Insipid, eatable (<i>Purslane</i>).
Sepals four or five, united into a tube	. . . . .	. . . 94. Silenaceæ	⚔	. Inert.
Sepals four or five distinct	. . . . .	. . . 95. Alsiniaceæ	⚔	. Inert.
Dehiscence of fruit loculicidal (435).	Seeds hairy	. . . 96. Tamaricaceæ	. . .	. Slightly astringent.
Leaves with stipules	. . . . .	. . . 97. Illecebraceæ	. . .	. Ditto.

All these orders correspond in so intimate a manner as to leave little doubt of their being correctly associated. Malvales and Meliales are the highest form of the group, Silenales the lowest; while Rham-

nales on the one hand, and Euphorbiales on the other, form the connection. The Syncarpous group passes into Epigynose by Lythraceæ, and into Gynobaseosæ by Aurantiacæ.

GROUP VI. GYNOBASEOSÆ.

Alliance 1. *Rutales*. Style single; (or at least the leaves dotted.)

Gynobase (397. a) fleshy.	Carpels distinct	. . . 98. Ochnaceæ Tonic, stomachic.
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Leaves alternate.	Stamens arising from scales	99. Simarubaceæ	Bitter (<i>Quassia</i>).
Stipules 0.	Fruit capsular	100. Rutaceæ ☞	Bitter, anthelmintic (<i>Rue</i>).
		100 ♀ Diosmeæ ☞	Antispasmodic (<i>Bucku</i>); febrifugal (<i>Angostura Bark</i>).
Stipules present.	Leaves opposite	101. Zygophyllaceæ ☞	Sudorific, alterative (<i>Guaiacum</i>).
Flowers unisexual		102. Xanthoxylaceæ	Aromatic, pungent.

Alliance 2. *Geraniales*. Styles distinct; at least near the point. Carpels combined.

Fruit beaked, separating into five cocci	103. Geraniaceæ ☞	Astringent.
Fruit not beaked. Flowers irregular	104. Balsaminaceæ	Diuretic.
	104. ♀ Hydrocereeæ.	
Fruit not beaked. Flowers regular	104. ♀ Tropæoleæ	Pungent (<i>Nasturtium</i>).
	105. Oxalidaceæ	Acid.

Alliance 3. *Coriales*. Styles several, and carpels quite distinct.

Ovules pendulous.	Embryo straight	106. Coriariaceæ	Fruit poisonous. Dyes black.
Ovules ascending.	Embryo bent double	107. Surianaceæ.	

Alliance 4. *Flörkeales*. Style simple. Fruit divided into deep lobes.

108. Limnanthaceæ	Pungent.
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This is undoubtedly a very natural group; but the student will be very likely to confound it with other groups, unless he pays great attention to its distinctions. In addition to the receptacle rising up more or less between the carpels, so as to make them diverge from each other at the base, it is to be remembered that they form only one single whorl, and do not exceed five in number. If this is neglected they may be confused with some Rosaceæ, Malvaceæ, &c. The group

is very incomplete, and may be expected to be much altered and increased before its orders are finally settled.

Rutales connect this with the Syncarpous group through Luvunga a genus belonging to Aurantaceæ. Flörkeales distinctly pass into Rosales through the genus Flörkea. Geraniales join this to the Pa-rietosæ group through Violales, and it is probable that Rutales also lead to the Calycosæ group.

GROUP VII. APOCARPOSÆ.

Alliance 1. *Rosales*. Albumen wholly absent.

Flowers quite regular	. . . . .	109. Rosaceæ ☞	. . . . .	Astringent.
		109. ♂ Pomœ	. . . . .	Fruit, eatable (<i>Apples</i>).
		109. ♂ Amygdalœ ☞	. . . . .	Bark, tonic; Prussic acid (<i>Laurel</i>); fruit eatable (<i>Peach</i>).
		109. ♂ Sanguisorbeæ	. . . . .	Astringent (<i>Burnet</i>).
Legume-bearing, with the radicle next the hilum	. . . . .	110. Leguminosæ ☞	. . . . .	Leaves and fruit eatable (<i>Pulse</i>).
		110. ♂ Swartzieæ.	. . . . .
		110. ♂ Cæsalpinieæ ☞	. . . . .	Purgative (<i>Senna</i>).
		110. ♂ Mimoseæ ☞	. . . . .	Astringent (<i>Catechu</i>).
Legume-bearing, with the radicle remote from the hilum	. . . . .	111. Connaraceæ	. . . . .	Gummy (<i>Gum Arabic</i>).
Style from the base of the carpels	. . . . .	112. Chrysobalanaceæ	. . . . .	Fruit eatable.
Petals very numerous	. . . . .	113. Calycanthaceæ	. . . . .	Fragrant.

Alliance 2. *Sarales*. Carpels two, diverging. Seeds very numerous with albumen.

Anthers opening by pores.	Polyandrous	. . . . .	114. Baneraceæ.	
Leaves opposite.	Stipules between the petioles	. . . . .	115. Cunoniaceæ	Astringent.
Leaves alternate	. . . . .	. . . . .	116. Saxifragaceæ ☞	Astringent.

Alliance 3. *Crassales*. Carpels several. Seeds very numerous with albumen.

Succulent plants	117. Crassulaceæ ☞	Refrigerant, abstergent (<i>Houseleek</i> .)
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Alliance 4. *Balsamales*. Abounding in balsamic juice.

Leaves dotted. Carpels solitary	118. Amyridaceæ	Fragrant, resinous (Gum <i>Elemi</i>).
Leaves not dotted	119. Anacardiaceæ	Resinous, poisonous (<i>Cashew</i>).

This group evidently passes into Albuminosæ by Rosaceæ and Ranunculaceæ, and also by Calycanthaceæ and Magnoliaceæ; and into Gynobaseosæ by Flörkea. It is probable that the divisions into alliances require much re-examination; but there can be no doubt

It is obvious from the notes appended to each of the foregoing groups, that their mutual relations may be expressed as follows:—

1. Albuminosæ pass into Epigynosæ through Eupomatia.
2. Epigynosæ — Parietosæ — Passiflora.
3. Parietosæ — Calycosæ — Turnera.
4. Calycosæ — Syncarposæ — Hugoniaceæ.
5. Syncarposæ — Gynobaseosæ — Luvunga.
6. Gynobaseosæ — Apocarposæ — Flörkea.
7. Apocarposæ — Albuminosæ — Ranunculaceæ and Calycanthaceæ.

Their true relations will therefore be better expressed as follows:—

Epigynosæ	Albuminosæ Apocarposæ
Parietosæ Calycosæ Syncarposæ.	Gynobaseosæ

This subclass is otherwise allied as follows;—

With Incompleteæ through Rhinales	Daphnales.
Euphorbiaceæ	— Empetrea.
Loranthaceæ	— Proteaceæ.
? Myristicaceæ	— Lauraceæ.
With Monopetalæ through Guttaceæ	— Ebenaceæ.
Umbellaceæ	— Stellaceæ and Ca-
	prifoliaceæ.
Rhamnaceæ	— Myrsinaceæ.
Rutaceæ	— Ericaceæ.
Cunoniaceæ	— Cinchonaceæ.
Melastomaceæ	— Gentianaceæ.
With Endogenæ through Ranunculaceæ	— Alismaceæ.
Nymphæaceæ	— Hydrocharaceæ.

SUBCLASS II. INCOMPLETEÆ.

These comprehend the following groups:—

1. RECTEMBRYOSÆ. Calyx very imperfect. Embryo straight.
2. ACHLAMYDOSÆ. Calyx and corolla altogether absent.
3. TUBIFEROSÆ. Calyx tubular, often resembling a corolla (and with none of the characters of the other groups).

4. **COLUMNOSÆ.** Stamens monadelphous, and ovary many-(six-)celled; or, at all events, the latter character combined with an epigynous flower.
5. **CURVEMBRYOSÆ.** Embryo curved round albumen; or having the form of a horseshoe; or spiral; (calyx rarely tubular).

GROUP I. RECTEMBRYOSÆ.

Alliance 1. *Amentales.* Flowers in catkins. Carpels several.

- Female flowers surrounded by a cupule . . . 120. Cupulacæ **¶** . . . Bark astringent (*Oak*).
 Female flowers arranged in scaly catkins . . . 121. Betulacæ . . . Ditto.

Alliance 2. *Urticales.* Carpel solitary, or several. Stems continuous without sheaths.

- Leaves opposite. Calyx superior . . . 122. Garryacæ.
 Leaves opposite. Calyx inferior . . . 123. Hensloviacæ.
 Leaves rough. Anthers bursting longitudinally . . . 124. Urticacæ **¶** . . . Narcotic, tough (*Hemp*).
 124. δ Moreæ *Endl.* . . . Fruit eatable (*Mulberry*).
 124. δ Artocarpeæ **¶** . . . Milky, juice poisonous
 (*Upas*), fruit eatable (*Fig*).
 124. δ Ceratophylleæ.

- Anthers bursting transversely . . . 125. Stilaginacæ.
 Inspid plants with hypogynous flowers . . . 126. Empetracæ . . . Slightly acrid.
 Aromatic plants with hypogynous flowers . . . 127. Myricacæ . . . Aromatic, tonic.
 Balsamic plants with epigynous flowers . . . 128. Juglandacæ . . . Fruit eatable (*Walnut*).

N. B. The stigma of Empetrum and its hypogynous scales seem, among other things, to show that the true affinity of that plant is with Myrica. It is a sort of transition to Euphorbiacæ.

Alliance 3. *Casuarales.* Carpels solitary. Stems jointed and furnished with sheaths.

129. Casuaracæ.

ance 4. *Ulm*es. Carpels two. Leaves rough.

130. Ulmaceae  . . . Bitter, astringent (*Elm*).

Alliance 5. *Datiscales*. Seeds numerous. Leaves alternate. Leaves alternate.

Flowers epigynous 131.
Datisacae Bitter.

Flowers hypogynous	. . .	132. Lacistemaceæ.
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Of the orders in this most natural group Garryaceæ point to Gnetales through Chloranthaceæ, and so establish a connection with Gymnospermous Exogens. Their approximation to Curvembryosæ by Urticaceæ is pointed out under that group. Their relation to Achlamydosæ is demonstrated by Ceratophyllæ, Lacisternaceæ, Podostemaceæ, and Callitrichaceæ.

GROUP II. ACHLAMYDOSÆ.

Alliance 1. *Piperalea*. Flowers in spikes. Apocarpous.

Leaves opposite, with interpetiolar stipules

Leaves alternate. Carpels several

Leaves alternate. **Carpels solitary**

Alliance 2. Salicales. Flowers:

Polyspermon

190. *Calyceraceae*.

191. Mutisaceae.

192. *Cichoraceae* - 73

193. *Asteraceae*

194. Cynaraceae 

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. Bitter, astringent (*Plantain*).

. Bitter, tonic, purgative.

that part to be spurious, and that the fruit is in reality quite simple.

flowers formed upon a quinary plan.

200. Plumbaginaceæ . . . Some tonic, astringent ;
others acrid, caustic.

GROUP IV. LABIOSÆ.

from two to four, in each carpel.

. Tonic, stomachic (*Thyme*,
Mint, &c.).
. Slightly bitter.
. Tanning.

201. Labiaceæ . . .

202. Verbenaceæ . . .

203. Myoporaceæ . . .

204. Selaginaceæ.

205. Stilbaceæ.

two-celled . . . yet the latter is in reality composed of only two carpels, as is proved by monstrous cases.

Leafy arborescent plants, with leafy crumpled cotyledons 150. *Illigeraceæ Blum.*
 Leafless, herbaceous, insipid plants 151. *Cassythaceæ.*

Alliance 5. *Penæales.* Carpels several.

152. *Penæaceæ* Sweetish, nauseous, gummy, resinous (*Sarcocöl*).

Their tubular calyxes distinguish them at once from all the other groups, except *Columnosæ*; and the latter are in general clearly characterised by their stamens united into a column. *Tubiferosæ* | touch *Achlamydosæ* by *Lauraceæ*, and *Columnosæ* by *Aristolochiaceæ*. They are also strongly related to *Curvembryosæ* by *Elæagnaceæ*.

GROUP IV. COLUMNOSÆ.

Alliance 1. *Nepenthales.* Flowers hypogynous.

153. *Nepenthaceæ.*

Alliance 2. *Aristolochiales.* Flowers epigynous.

154. *Aristolochiaceæ* \P . Tonic, stimulating.

GROUP V. CURVEMBRYOSÆ.

Alliance 1. *Chenopodales.* Albumen present. Radicle next the hilum.

Flowers dry, with numerous bracts 155. *Amarantaceæ* \P . Wholesome, insipid.
 Flowers herbaceous. Carpels solitary 156. *Chenopodiaceæ* \P . Ditto (*Spinach*).
 Flowers coloured. Carpels several 157. *Phytolaccaceæ* Emetic.

- Alliance 2. *Polygonales*. Albumen present. Radicle away from the hilum.
 158. *Polygonaceæ* 3 . Acid (*Sorrel*); purgative and tonic (*Rhubarb*).
- Alliance 3. *Petivales*. Albumen absent. Cotyledons spiral.
 159. *Petiveraceæ*.
- Alliance 4. *Sclerales*. Tube of the calyx hardened.
 Border of the calyx herbaceous 160. *Scleranthaceæ*.
 Border of the calyx petaloid 161. *Nyctaginaceæ* Roots purgative.
- Alliance 5. *Cocculales*. Albumen present. Flowers formed upon a ternary plan, dichlamydeous.

162. *Menispermaceæ* 3 . Root bitter, tonic (*Calumbo*); seeds narcotic (*Cocculus*).

In their technical character *Sclerales* seem to approach *Tubiferosæ*, they have not, however, much relation to them, and the resemblance in their calyx is overcome by the structure of the seed. *Nyctaginaceæ* require a much more careful examination than they yet have received. *Menispermaceæ* have, strictly speaking, both calyx and corolla; but their organs are so small and so much alike, that I have no hesitation in placing the order here; it has but little apparent relation even to

Schizandree among *Anonales*, beyond the circumstance of the parts of its flower being ternary, while it seems closely allied to *Aristolochiaceæ*. *Menispermaceæ* must be considered one of the natural orders among *Exogens* which tend towards *Endogens*. The passage of *Curvembryosæ* into *Rectembryosæ* through *Chenopodiaceæ* on the one hand, and *Urticaceæ* on the other, is obvious.

- The mutual relations of these groups may be expressed as follows:—
1. *Rectembryosæ* pass into *Achlamydosæ* through *Garryaceæ*, &c.
 2. *Achlamydosæ* — *Tubiferosæ* — *Monimiaceæ*.
 3. *Tubiferosæ* — *Columnosæ* — *Aristolochiaceæ*.
 4. *Columnosæ* — *Curvembryosæ* — *Menispermaceæ*.
 5. *Curvembryosæ* — *Rectembryosæ* — *Chenopodiaceæ*.
- Their true relations will therefore be thus,
- Rectembryosæ* *Curvembryosæ*
Achlamydosæ *Columnosæ*.
Tubiferosæ.

The subclass of *Incompleteæ* may be considered allied with other parts of the system in the following manner, viz.:

With Polypetalæ through	Daphnales	to	Rhamnales.
	Proteaceæ	—	Loranthaceæ.
	Laureæ	—	Myristicaceæ.
	Empetraceæ	—	Euphorbiaceæ.
With Monopetalæ	—	—	Nyctaginaceæ
With Gymnospermæ	—	—	Chloranthaceæ
With Endogenæ	—	—	Menispermaceæ
		—	Aristolochiaceæ
		—	Araceæ.

SUBCLASS III. MONOPETALÆ.

These comprehend the following groups:—

1. POLYCARPOSÆ. Flowers hypogynous (rarely epigynous). Ovary composed of many carpels.
2. EPIGYNOSÆ. Flowers epigynous. Ovary composed of two or many carpels.
3. AGGREGOSÆ. Ovary consisting of but one perfect carpel.
4. LABIOSÆ. Flowers hypogynous unsymmetrical. Ovary composed of two carpels.
5. DICARPOSÆ. Flowers hypogynous and symmetrical. Ovary composed of two carpels.

GROUP I. POLYCARPOSÆ.

Alliance 1. *Breviales*. Albumen absent. Carpels five.

163. Brexiaceæ.

Alliance 2. *Ericales*. Anthers opening by pores. Carpels from four to five, or more.

- | | | | | | | |
|----------------------------|----------------|---|---|--------------------|---|---------------------------------|
| Seeds winged. | Herbs | . | . | 164. Pyrolaceæ | . | Diuretic, tonic. |
| Brown, leafless, parasites | . | . | . | 165. Monotropaceæ. | . | |
| Anthers two-celled. | Seeds wingless | . | . | 166. Ericaceæ | . | Astringent, diuretic, narcotic. |
| Anthers two-celled. | Ovary inferior | . | . | 167. Vacciniaceæ | . | Ditto, ditto. |
| Anthers one-celled | . | . | . | 168. Epacridaceæ. | . | |

Alliance 3. *Primulales*. Anthers bursting longitudinally. Carpels four—five.

- | | | | | | |
|--------------------|--------------------------|---|--------------------------------|---|--|
| Herbaceous plants. | Stamens opposite petals | . | 169. Primulaceæ | . | Slightly narcotic (<i>Crosslip</i>). |
| Woody plants. | Stamens opposite petals. | . | 170. Myrsinaceæ. | . | |
| | | | 170. § <i>Ægiceræe Blume</i> . | | |
| Milky plants. | Calyx and corolla double | . | 171. Sapotaceæ | . | Fruit sweet, eatable; bark febrifugal. |

Stamens distinct. Seeds indefinite . . . , 184. Goodeniaceæ.
 Stamens distinct. Seeds definite . . . , 185. Scævolaçæ.

Alliance 3. *Cinchonales*. Stipules between the leaves.

Albumen present , 186. Cinchonaceæ ☞ . Bark febrifugal (*Jesuits' bark*).
 Albumen absent , 187. Lygodysiadiaceæ . . . Root emetic (*Ipecacuanha*.)

Alliance 4. *Capriales*. Stipules none. Seeds definite in number.

188. Caprifoliaceæ ☞ . Bark astringent.

Alliance 5. *Stellales*. Fruit double. Leaves whorled, with no stipules.

189. Stellaceæ ☞ . . . Astringent, dyes (*Madder*.)

It is evident that in this group, Stellaceæ have a close relationship with Umbellaceæ; and that this approximation is participated in by alliance, by means of Scævolaçæ, passes directly into Brunoniaceæ Caprifoliaceæ, through the genera Viburnum and Sambucus. Some among Aggregosæ.

GROUP III. AGGREGOSÆ.

Alliance 1. *Asterales*. Anthers syngenesious.

Albumen present in the seeds . . . , 190. Calyceraceæ.
 Corolla bilabiate , 191. Mutisiaceæ.
 Corollas all ligulate. Milky . . . , 192. Cichoraceæ ☞ . . . Narcotic (*Lettuce*).
 Involute cre hemispherical. Flowers of ray ligulate . 193. Asteraceæ ☞ . . . Bitter, tonic (*Chamomile*) diuretic.
 Involucre rigid or spiny, conical. Flowers of ray tubular and inflated . . . , 194. Cynaraceæ ☞ . . . Bitter (*Thistle*).

Alliance 2. *Dipsales*. Anthers distinct. Flowers epigynous.

Carpel solitary	. . . . .	195. Dipsacæ	☞	. None.
Carpels triple; two of them abortive	. . . . .	196. Valerianacæ	☞	. Bitter, antispasmodic, vermifugal (<i>Valerian</i>).

Alliance 3. *Brunoniales*. Style single. Stigma with an indusium.

197. Brunoniacæ.

Alliance 4. *Plantales*. Style single. Stigma naked.

Fruit spuriously double celled	. . . . .	198. Plantaginacæ	. . . . .	. Bitter, astringent (<i>Plantain</i>).
Flowers unsymmetrical	. . . . .	199. Globulariacæ	. . . . .	. Bitter, tonic, purgative.
N.B. The situation of the dissepiment in <i>Plantaginacæ</i> sufficiently shows that part to be spurious, and that the fruit is in reality quite simple.				

Alliance 5. *Plumbales*. Styles five. Flowers formed upon a quinary plan.

200. Plumbaginacæ	Some tonic, astringent; others acrid, caustic.
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GROUP IV. LABIOSÆ.

Alliance 1. *Labiales*. Ovules from two to four, in each carpel.

Fruit divided into four lobes	. . . . .	201. Labiacæ	☞	. Tonic, stomachic (<i>Thyme</i> , <i>Mint</i> , &c.).
Fruit consisting of about four cells.	Radicle inferior	202. Verbenacæ	. . . . .	. Slightly bitter.
Ditto, ditto.	Radicle superior	203. Myoporacæ	. . . . .	. Tanning.
Fruit two-celled.	Ovules pendulous.	Anthers		
one-celled	. . . . .	204. Selaginacæ.		
Ditto. Ovules erect.	Anthers two-celled	. . . . .	205. Stilbacæ.	

N. B. Although *Labiacæ* have a four-lobed ovary, yet the latter is in reality composed of only two carpels, as is proved by monstrous cases.

Alliance 2. *Bignoniales*. Neither albumen nor hooks to the seeds.

Seeds winged	206. Bignoniaceæ.	
Fruit hard and like a nut	207. Pedaliaceæ	Emollient.
Placentæ 4. Seeds wingless	208. Cyrtandraceæ	

Alliance 3. *Scrophulales*. Seeds numerous, with albumen.

Leafy plants with a superior ovary	209. Scrophulariaceæ	
Leafless plants with a minute embryo	210. Orobanchaceæ.	
Leafless plants with a one-celled ovary, partly inferior	211. Gesneraceæ	Harmless.
		Suspicious (<i>Digitalis</i>).

Alliance 4. *Acanthales*. Seeds without albumen, with hooks to the seeds. Calyx remarkably imbricated.

212. Acanthaceæ. 


Alliance 5. *Lentibales*. A free central placenta.

213. Lentibulaceæ.

Labiaceæ connect these plants with the bilabiate Asterales, and Scrophulariaceæ with Solanaceæ in Labiosæ.

Group V. DICARPOSÆ.

Alliance 1. *Gentianales*. Flowers symmetrical. Carpels standing right and left of the axis of inflorescence. ()

Corolla withering on the fruit; in æstivation imbricated	214. Gentianaceæ 	Bitter (<i>Gentian</i>).
Æstivation of corolla valvate	215. Spigeliaceæ	Anthelmintic.

Æstivation contorted. Stamens distinct . . . 216. Apocynaceæ . . . Milk and fruit poisonous (*Nux Vomica*); bark febrifugal sometimes. . . Acrid. Emetic.

Anthers grown to the stigma . . . 217. Asclepiaceæ ☞

Alliance 2. *Oleales*. Diandrous.

Æstivation of corolla valvate . . . 218. Oleaceæ ☞ . . . Oil eatable (*Olive*).
 Æstivation of corolla imbricate . . . 219. Jasmīnaceæ.

Alliance 3. *Loganiales*. Flowers unsymmetrical with several stamens.

Leaves furnished with stipules . . . 220. Loganiaceæ.
 Flowers somewhat pentandrous . . . 221. Potaliaceæ . . . Acrid. Emetic.

Alliance 4. *Echiales*. Inflorescence gyrate.

Fruit deeply lobed . . . 222. Boraginaceæ ☞ . . . Mucilaginous (*Borage*);
 Roots dye (*Alkanet*).
 Syncarpous. Style bifid . . . 223. Ehretiaceæ.
 Syncarpous. Style dichotomous . . . 223. § Heliotropiceæ.
 Fruit unilocular, with parietal or basal placenta . . . 224. Cordiaceæ . . . Emollient (*Sebesten Plum*).
 . . . 225. Hydrophyllaceæ.

Alliance 5. *Solanales*. Flowers symmetrical. Carpels standing fore and aft of the axis of inflorescence. ()

Embryo curved. Cotyledons cylindrical . . . 226. Solanaceæ ☞ . . . Poisonous. Narcotic (*Belladonna*, *Stramonium*, *Tobacco*).
 Embryo straight. Cotyledons leafy . . . 227. Cestraceæ.

These regular-flowered orders, with two carpels in each ovary, latter through Solanaceæ, and they pass into Polycarpoe by Boraginaceæ. Gentianaceæ connect them with Polypetalæ.

It appears that the connection between the foregoing groups is of a most decisive nature; for,

1. Polycarpoe pass into Epigynoe through Primulales.
2. Epigynoe — Aggregoe — Scævolaceæ.
3. Aggregoe — Labiosæ — Dipsacæ.
4. Labiosæ — Dicarposæ — Scrophulariaceæ.
5. Dicarposæ — Polycarpoe — Boraginaceæ.

The relations of the groups may therefore be expressed thus, —

Polycarpoe, Dicarposæ,
Epigynoe, Aggregoe,
Labiosæ,

With regard to the connection of Monopetalous Exogens with other parts of the system, they appear to have only the following strongly-marked affinities: —

With Polypetalæ through Gentianaceæ to Melastomaceæ.

With Polypetalæ through
Ebenaceæ } to Guttaceæ.
Stellaceæ }
Caprifoliaceæ } — Umbellaceæ
Myrsinaceæ } — Rhamnaceæ.
Ericaceæ } — Rutaceæ.
Cinchonaceæ } — Cunoniaceæ.
? Solanaceæ } — Nyctaginaceæ.

It also results from the previous investigations, that true Exogens are only connected immediately with other classes by the following points: —

With Endogens through
Ranunculaceæ to Alismaceæ.
Nymphaeaceæ — Hydrocharaceæ.
Menispermaceæ — Smilacæ.
Aristolochiaceæ — Araceæ.
Chloranthaceæ — Gnetaceæ.

With Gymnospermæ —

CLASS II. GYMNOSPERMÆ.

Stem with articulations.	Fruit in spikes . . .	228. Gnetaceæ.	
Stem bearing many buds.	Fruit single . . .	229. Taxaceæ	Seeds deleterious (<i>Yew</i>).
Acotyledonous, with incomplete sexual organs		230. Equisetaceæ	Cuticle siliceous (<i>Dutch rushes</i>); slightly stimulating.
Stem terminated by a single bud.	Leaves gyrate before development . . .	231. Cycadaceæ	Wood contains starch.
Stem bearing many buds.	Fruit in cones . . .	232. Conaceæ	Terebintaceous (<i>Turpentine, Pitch, &c.</i>).

Equisetum appears to be really the lowest form of sexual plants; in inflorescence, the presence of a vascular system, in sexes (for their clavate filaments are apparently equivalent to anthers, and their nucleus to an ovule), in habit, and, finally, in the presence of rudimentary woody plates in their trunk, they agree with sexual plants. On the

other hand, they only agree with sexless plants in the imperfect condition of their anthers and ovule; and this latter character is of less importance now that the nature of Rhizanthæa begins to be understood. It is not improbable that the true place of Characæ is in this class, as a lower form than even Equisetacæ.

These plants are connected by close affinity; but some links in the chain are wanting —

Gnetacæ pass into Taxacæ.
 Taxacæ — Equisetacæ through Ephedra.
 Equisetacæ — Cycadacæ — Zamia.
 Cycadacæ — Conacæ — Araucaria?
 And they consequently stand thus, —
 Gnetacæ Conacæ.
 Taxacæ Equisetacæ. Cycadacæ.

They are in alliance with other parts of the system, thus, —
 With Exogens through Gnetacæ to Chloranthacæ.
 With Endogens — Cycadacæ — Palmacæ.
 With Acrogens — Conacæ — Lycopodiaceæ.
 Cycadacæ — Filicales.
 Equisetacæ — Characæ

CLASS III. ENDOGENÆ.

These comprehend the following groups : —

1. EPIGYNOSÆ. Anthers distinct. Flowers complete. Ovary inferior.
2. SPADICOSÆ. Flowers herbaceous, or imperfect, or even coloured; but in that case with its parts in twos, and the ovary superior.
3. GLUMOSÆ. Bracts scalelike in the room of a perianth.
4. HYPOGYNOSÆ. Flowers coloured, with its parts in threes. Ovary superior.
5. GYNANDROSÆ. Stamens united with the styles. Flowers complete. Ovary inferior.

GROUP I. EPIGYNOSÆ.

Alliance 1. *Amomales*. Leaves with the veins diverging from the midrib to the margin.

Monandrous. Anther two-celled 233. Zingiberacæ ☞ . Aromatic, stimulating (*Ginger*.)

Monandrous. Anther one-celled . . . 234. Marantaceæ **⚔** . . . Amylaceous, insipid (*Arrow-root*).
 Several anthers 235. Musaceæ **⚔** . . . Fruit nutritious (*Banana*).

Alliance 2. *Narcissales*. Hexapetaloides hexandrous plants.

Flowers small. Texture harsh 236. Hypoxidaceæ.
 Flowers large. Texture smooth 237. Amaryllaceæ **⚔** . . . Acrid. Poisonous.
 Leaves equitant. Plant woolly 238. Hæmodoraceæ.
 Leaves equitant. Fruit winged 239. Burmanniaceæ.
 Fruit one-celled. Placentæ parietal 240. Taccaceæ.

Alliance 3. *Iriales*. Triandrous.

241. Iridaceæ **⚔** . . . Almost inert.

Alliance 4. *Bromeliales*. Tripetaloides scurfy plants (with albumen).

242. Bromeliaceæ . . . Sap sugary (*Pine-apple*.)

Alliance 5. *Hydrales*. Tripetaloides smooth plants. Stamens more than six. (Albumen absent).

243. Hydrocharaceæ.

Both Hydrocharaceæ and Bromeliaceæ pass into Spadicoseæ by Pandanaceæ. Iridaceæ, particularly the genus *Gladiolus*, offer a very near approach in structure to Gynandroseæ.

GROUP II. SPADICOSÆ.

Alliance 1. *Pandales*. Flowers on a spadix (259.). Fruit drupaceous.

Flowers spiral. Spires alternately male and female 244. Cyclanthaceæ.
 Flowers achlamydeous and apocarpous . . . 245. Pandanaceæ. . . Fruit eatable.

Alliance 2. *Arales*. Flowers on a spadix. Fruit either berried or capsular.

Flowers unisexual 246. Araceæ **⚔** . . . Acrid. Poisonous.
 Flowers hermaphrodite 247. Acoraceæ . . . Aromatic.

Alliance 3. *Typhales*. Flowers on a spadix. Sepals three. Anthers clavate.

248. Typhaceæ . . . Of no importance.

Alliance 4. *Smilales*. Flowers in lax racemes. Leaves deciduous.

Flowers unisexual. Ovary inferior . . . 249. Dioscoreaceæ . . . Roots eatable (*Yam*).
 Flowers hermaphrodite. Ovary superior . . . 250. Smilaceæ . . . Diuretic. Demulcent (*Sarsaparilla*).
 Parts of the flower in two. Perianth highly developed . . . 251. Roxburghiaceæ.

Alliance 5. *Fluviales*. Flowers in spikes, or solitary.

Floater. Ovules pendulous . . . 252. Fluviaceæ . . . Unimportant.
 Terrestrial. Ovules erect . . . 253. Juncaginaceæ.
 Floaters, with none, or scarcely any, axis of growth 254. Pistiaceæ . . . Acrid (*Duck-weed*).

It is here that we find a transition to Rhizanthese in the case of the known form of Endogens. Typhaceæ connect this group with Glugenus Lemna, which is destitute of vascular system, and is the lowest mossæ, and Pandales with Epigynose.

GROUP III. GLUMOSÆ.

Stems fistular . . . 255. Graminaceæ P . . . Fruit floury (*Corn*). Herbage sweet (*Sugar-cane*, *Grass*, &c.).
 Stems solid. Carpels single . . . 256. Cyperaceæ P . . . Diaphoretic. Unimportant.
 Flowers naked. Carpels several . . . 257. Desvauxiaceæ.
 Flowers with a calyx. Seeds few . . . 258. Restiaceæ.
 Flowers with a corolla. Seeds numerous . . . 258. δ Eriocaulonæ.
 . . . 259. Xyridaceæ.

United to Spadicoseæ by Cyperaceæ, and to Hypogynoseæ by Restiaceæ.

GROUP IV. HYPOGYNOSÆ.

Alliance 1. *Palmates*. Hexapetaloidous plants, with a vague embryo.

260. Palmaceæ ☞ . . . Amylaceous. Saccharine-
(*Cocoa nut*. *Sago*).

Alliance 2. *Liliales*. Hexapetaloidous plants, with an embryo in the axis of the albumen.

- Petals rolled inwards after flowering . . . 261. Pontederaceæ.
Hexandrous. Anthers turned outwards. Styles
distinct 262. Melanthaceæ ☞ . . Cathartic; narcotic; diuretic
(*White Hellebore*. *Colchicum*).

Flowers irregular, with appendages on the outside 263. Gilliesiaceæ.

Hexandrous. Anthers turned inwards. Styles
consolidated 264. Liliaceæ . . . Unimportant.

264. § Asphodeleæ ☞ . Bitter, stimulant (*Squill*,
Onion, &c.).

Alliance 3. *Commelales*. Tripetaloidous plants, with the carpels three and consolidated.

265. Commelinaceæ.

Alliance 4. *Alismales*. Tripetaloidous plants, with the carpels more or less distinct.

- Placentæ spread over the dissepiments . . . 266. Butomaceæ ☞ . . Acrid.
Placentæ occupying the margin only of the dissepiments, or their equivalent . . . 267. Alismaceæ . . . Acrid.

Alliance 5: *Juncales*. Flowers somewhat glumaceous.

- Flowers regular 268. Juncaceæ ☞ . . . Unimportant.

Flowers irregular, with a two-leaved calyx . . . 269. Philodracæ.

Here we have a marked transition to Exogens on the part of Alisma, bryo. Liliaceæ connect the group with Gynandrosæ through Apo-
which is hardly distinguishable from Ranunculaceæ, except by its em- stasiaceæ, Juncaceæ with Glumosæ through Restiaceæ.

GROUP V. GYNANDROSÆ.

- Flowers monandrous. Seeds in a loose skin . . . 270. Orchidaceæ **B** . . . Aromatic. Viscid (*Salep*).
Flowers monandrous. Seeds with a tight skin.
Creepers . . . 271. Vanillaceæ . . . Aromatic fruit (*Vanilla*).
Flowers diandrous. Ovary three-celled . . . 272. Apostasiaceæ.
Flowers diandrous. Ovary one-celled . . . 273. Cyripediaceæ.

The flowers of a *Gladiolus* would become those of an *Orchis* in calyx and corolla and stamens, if the latter were consolidated with the style; here there is a transition to Epigynosæ. Apostasiaceæ have

The connection of these groups seems to be something in this manner, —

1. Epigynosæ pass into Spadicosæ through Bromeliales.
2. Spadicosæ — Glumosæ — Typhaceæ.
3. Glumosæ — Hypogynosæ — Restiaceæ.
4. Hypogynosæ — Gynandrosæ — Liliaceæ & Asphodeleæ.
5. Gynandrosæ — Epigynosæ — Orchidaceæ.
Their relative positions will therefore be,
Epigynosæ, Gynandrosæ, Hypogynosæ,
Spadicosæ, Glumosæ.

The relation of Endogens with other parts of the system seems to be, —
With Gymnospermæ through Palmaceæ to Cycadaceæ.
With Exogens — Alismaceæ — Ranunculaceæ.
— Hydrocharaceæ — Nymphaeaceæ.
— Smilacæ — Menispermaceæ.
— Araceæ — Aristolochiaceæ.
With Rhizanthææ through Araceæ — Balanophoraceæ.
With Acrogens — Pistiaceæ ? — Marsileaceæ ?

CLASS IV. RHIZANTHÆÆ.

- Sepals several. Placentæ parietal . . . 274. Rafflesiaceæ **B** . . . Astringent.
Sepals four. Placentæ parietal . . . 275. Cytinaceæ . . . Astringent.
Sepals none. Placentæ central . . . 276. Balanophoraceæ. **B**
Sepals none. Stamens distinct. Placentæ central 277. Cynomoriaceæ . . . Astringent (*Fungus melitensis*).

These singular fungoid plants are neither Exogens nor Endogens, because they have no vascular system, and their sexual apparatus is imperfect; they are not Acrogens, because they have flowers and

sexes. They are connected
With Endogens through Araceæ.
With Acrogens — Fungaceæ.

CLASS V. ACROGENÆ.

Alliance 1. *Filicales*. Stems fistular, vascular. Reproductive organs borne upon the leaves.

Ring of the thecæ vertical	.	.	.	278. Polypodiaceæ ¶	} Astringent. Pectoral. Some eatable.
				278. § <i>Cyathea</i> <i>Endl.</i>	
Ring of the thecæ transverse	.	.	.	279. <i>Gleicheniaceæ</i>	
				279. § <i>Parkeriaceæ</i>	
				279. § <i>Hymenophylleæ</i>	
				<i>Endl.</i>	
Ring wanting.	Thecæ one-celled, ribbed	.	.	280. <i>Osmundaceæ</i>	.
Ring wanting.	Thecæ as if many-celled	.	.	281. <i>Danaæaceæ</i>	.
Ring wanting.	Thecæ one-celled, veinless	.	.	282. <i>Ophioglossaceæ</i>	.

Alliance 2. *Lycopodales*. Stems solid, vascular. Reproductive organs growing on the stem.

Thecæ naked	.	.	.	283. <i>Lycopodiaceæ</i> ¶	. Emetic.
Thecæ enclosed in involucre of the same form	.	.	.	284. <i>Marsileaceæ</i>	. None.
Thecæ enclosed in involucre of two different forms	285. <i>Salviniaceæ</i>	.	.		. None.

Alliance 3. *Muscales*. Without a vascular system. Germinating processes uniting into a heterogeneous body. Sporules in distinct thecæ.

Thecæ valveless, with an operculum	.	.	.	286. <i>Muscaceæ</i> ¶	. Slightly astringent.
Thecæ opening into valves, with an operculum	.	.	.	287. <i>Andræaceæ</i> .	
Thecæ opening into valves, without an operculum	288. <i>Jungermanniaceæ</i> .				
Thecæ valveless, without an operculum	.	.	.	289. <i>Hepataceæ</i> .	

Alliance 4. *Charales*. Without a vascular system. Germinating processes uniting into a heterogeneous body. Reproductive organs axillary globules.

290. <i>Characeæ</i>	.	.	.	Fetid.
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Alliance 5. *Fungales*. Without a vascular system. Germinating processes either wholly distinct or confluent in a homogeneous body.

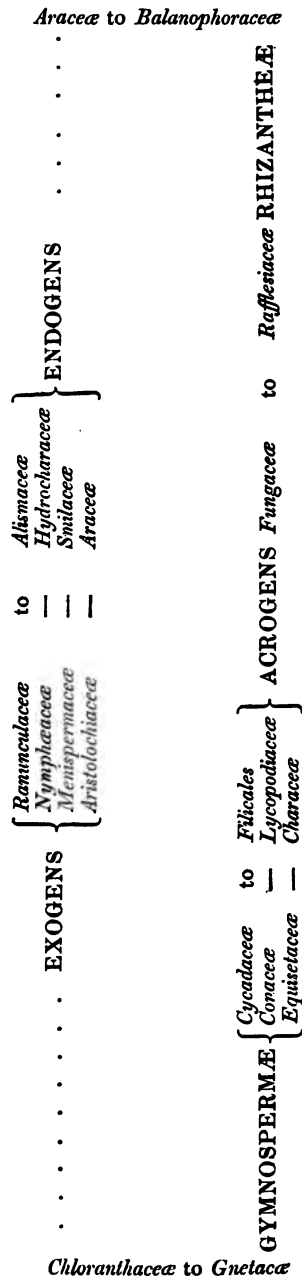
- Born from a matrix which veils them when young 291. Fungaceæ \mathfrak{A} . . Stimulant; nutritive. Often poisonous (*Ergot. Mushroom. Truffle*).
- Born without a matrix. Living in air. Cellular, rarely filamentous, with a reproductive nucleus bursting through their surface . . . 292. Lichenaceæ . . Dye (*Orchat*) Nutritive (*Ice-land Moss*).
- Born without a matrix. Living in water. Filamentous; the filaments either solitary or several glued together, having sporidia and viviparous . 293. Algaceæ . . Nutritive.

This group touches Rhizanthææ through Fungaceæ. Lycopodiaceæ. Filicales. Characeæ.

If the affinities that have thus been explained are correctly stated, a mutual connection of the five great classes in the vegetable kingdom, may be expressed by a circle, in the middle of whose circumference stand Exogens and Endogens, side by side; the common point of all the classes is formed by Acrogens; which are connected on the

one hand with Exogens by Gymnospermæ, and on the other with Endogens by Rhizanthææ.

The following scheme will place this idea in a more distinct point of view:—



I.

INDEX OF TECHNICAL TERMS.

N.B. The Numbers refer to the Paragraphs.

- | | | |
|----------------------------|----------------------------|---------------------------|
| Accessory principles, 215. | Berberry, 323. | Cone, 466. |
| Achlamydeous, 285. | Berry, 461. | Coniferæ, 31. 175. 333. |
| Acotyledons, 515. | Bourgeon, 142. | 396. 423. |
| Acrogenous, 80. | Bouton, 143. | Connective, 319. |
| Aculei, 140. | Bract, 229. | Convolvulus, 441. |
| Adventitious leaf-buds, | Bractlets, 229. | Cormus, 132. |
| 153. | Brassica, 458. | Corn, 453. |
| Æstivation, 301. | Bryophyllum, 192. | Corolla, 281. 291. |
| Aigrette, 283. | Bulb, 157. | Corymb, 264. |
| Air-vessels, 35. | Bulbous root, 157. | Cotton, 483. |
| Akenium, 452. | Calyptra, 525. | Cotyledons, 503. |
| Albumen, 415. 494. | Calyx, 280. 290. | Creeping root, 131. |
| Album, 101. | Cambium, 116. | Cruciferæ, 337. 386. |
| Alchemilla, 349. | Capitulum, 261. | Cucumber, 464. |
| Algæ, 62. 542. | Capsule, 457. | Cup, 336. |
| Amelanchier, 386. | Carbon, 5. | Cupule, 460. |
| Amentum, 260. | Carmichælia, 449. | Cuscuta, 515. |
| Anagallis, 437. | Carpel, 354. | Cuticle, 38. |
| Annulus, 532. | Carrot 233. | Cycadææ, 31. 175. 396. |
| Anona, 497. | Caruncula, 477. | 423. |
| Anther, 303. 318. | Caryopsis, 453. | Cyme, 267. |
| Antitropous, 521. | Cathartocarpus, 385. 422. | Daisy, 233. |
| Apex of seed, 480. | Cauliculus, 507. | Dehiscence, 321. |
| Apex of fruit, 428. | Cells, 320. | Dehiscence of fruit, 431. |
| Apex of ovule, 397. | Cellular tissue, 7. | Diadelphous, 315. |
| Apocarpous, 355.a. | Cellular tissue, muriform, | Dicotyledons, 512. |
| Apple, 391. 443. 463. 520. | 113. | Didymocarpus, 386. |
| Aril, 475. | Cellulares, 28. | Dissepiments, 376. |
| Arum, 232. 388. | Centrifugal, 269. | Dorsal suture, 430. |
| Ascending, 373. | Centripetal, 268. | Drupe, 451. |
| Ascidium, 169. | Chalaza, 491. 407. | Ducts, 29. |
| Asclepias, 351. | Chenopodium, 454. | dotted, 18.a. |
| Apocynæ, 186. | Chrysobalanæ, 349. | Eleusine, 454. |
| Apothecium, 541. | Citrons, monstrous, 366. | Embryo, 54. 499. |
| Asparagus, 127. | Cleome, 355. | Endocarp, 426. |
| Axillary, 255. | Clostres, 19. | Endogenous, 80. |
| Axis, 52. | Cocoa-nut, 421. | Endopleura, 485. |
| Axis of fruit, 429. | Collet, 60. 506. | Endorhizæ, 517. |
| Azalea, 522. 433. | Columella, 429. 536. | Epacris, 324. |
| Azote, 5. | Column, 316. | Epicarp, 426. |
| Bamboo, 128. | Coma, 483. | Epidermis, 42. 105. |
| Bark, 102. | Commissure, 429. | Epigynous, 314. |
| Barley, 523. | Compositæ, 326. | Epiphyllous, 252. |
| Base of ovule, 397. | Compound, 273. | Erect, 373. |
| Base of seed, 480. | Compound leaf, 181. | Eschscholtzia, 288. |
| Base of fruit, 428. | Compound organs, 50. | Etiolation, 225. |
| Baströhren, 19. | | Euphorbia, 387. 439. 497. |

- Euphorbiaceæ, 498.
 Exogenous, 80, 81.
 Exostome, 408.
 Exorhizæ, 517.
 Extra-axillary, 252.
 Expansion, 247.
 Fall of the leaf, 189.
 Fausses trachées, 29.
 Ferns, 529.
 Fig, 444. 468.
 Filament, 303. 315.
 Fir, 444.
 Floral leaf, 229.
 Floral envelopes, 227. 277.
 Follicle, 447.
 Foramen, 408.
 Flower-bud, 143. 227.
 Food, 198.
 Foreign principles, 216.
 Fragaria, 365. 367.
 Fruit, 417.
 Fungi, 543.
 Funiculus, 397.
 Galbulus, 466.
 Gemmation, 191.
 Gemmule, 504.
 Geranium, 387.
 Gesneria, 337.
 Gland, 460.
 Glumes, 237.
 Gooseberry, 461.
 Grape, 463.
 Gynandrous, 316.
 Gynobase, 337. a.
 Gynophore, 355.
 Hairs, 193.
 Hairs, lymphatic, 194.
 Hairs, secreting, 195.
 Hazel, 421. 460.
 Heart-wood, 100.
 Heterotropous, 522.
 Hilum, 479.
 Hippuris, 311.
 Hydrogen, 5.
 Hymenium, 543.
 Hypericum, 315.
 Hypogynous, 312.
 Indusium, 529.
 Inferior calyx, 892.
 Inferior ovary, 391.
 Inflorescence, 247.
 Iris, 348.
 Irregular flower, 298.
 Irritability, 204.
 Intercellular passages, 11.
 Internodes, 137.
 Involucre, 233.
 Labiata, 350.
 Lamina, 171.
 Lamium, 311. 337.
 Lathyrus, 350.
 Leaf-buds, 55. 142.
 Leaves, 158.
 Lecythis, 515.
 Legume, 448.
 Lenticular glands, 35.
 Leontice, 473.
 Liber, 104.
 Lichens, 541.
 Lilac, 435.
 Lilium, 389. 435.
 Limb, 287. 295.
 Lime-tree, 180.
 Liquor amnios, 416.
 Lobes, 319.
 Loculicidal, 435.
 Lomentaceous, 450.
 Lychnia, 457.
 Maize, 516. "
 Malaxis paludosa, 192.
 Malva, 315.
 Martynia, 386. 422.
 Medullary rays or plates, 113.
 Medullary sheath, 86.
 Mesosperm, 485.
 Micropyle, 487.
 Midrib, 174.
 Mignonnette, 481.
 Mimosa, 181.
 Mistletoe, 334.
 Monadelphous, 315.
 Monocotyledons, 511.
 Monopetalous, 291.
 Monophyllous, 290.
 Monosepalous, 290.
 Mosses, 535.
 Moutan, 338.
 Mucilage, 214.
 Multiple fruit, 442.
 Naked, 285.
 Naked seeds, 471.
 Neck, 60. 506.
 Nectarines, 299. 340.
 Nelumbium, 339.
 Nettle, 521.
 Nicotiana multivalvis, 366.
 Nodes, 136.
 Nucleus, 398.
 Nut, 382. 427. 443. 460.
 Nymphæa, 304.
 Oenothera, 328.
 Olynthia, 515.
 Onion, 334.
 Operculum, 535.
 Opposite the leaves, 252.
 Orange, 181. 334. 462.
 Orchis, 328.
 Ornithopus, 450.
 Orthotropous, 520.
 Ovary, 344.
 Ovule, 354. 393.
 Oxygen, 5.
 Pæony, 254. 336. 443. 447.
 Paleæ, 235. 237.
 Palm, 128. 180.
 Panicle, 265.
 Papilionaceous, 294.
 Pappus, 283. 483.
 Parenchyma, 7. 13. 15.
 Parietal, 380.
 Passiflora, 355.
 Pea, 315. 448. 487.
 Peach, 427. 451.
 Pear, monstrosous, 144.
 Pedicel, 240.
 Peduncle, 239.
 Pendulous, 372.
 Perianth, 284.
 Pericarp, 426.
 Perigone, 284.
 Perisperm, 494.
 Peristome, 536.
 Pepo, 464.
 Petals, 291.
 Petiolar, 252.
 Petiole, 165.
 Perigynous, 313.
 Phragmata, 385.
 Phyllodium, 168.
 Pine Apple, 444. 467.
 Pinus, 466.
 Piper, 501.
 Pistillum, 341.
 Pitcher, 169.
 Pith, 82.
 Placenta, 359.
 Plumule, 504.
 Podosperm, 897.
 Pollen, 318. 327.
 Polyadelphous, 315.
 Polypetalous, 291.
 Polysepalous, 290.
 Pome, 463.
 Pomegranate, 369.
 Poppy, 380. 438. 457.
 Pores, 322.
 Præfloration, 301.
 Prickles, 140.
 Primine, 399.
 Primrose, 522.
 Proper juice, 205.
 Proper vessels, 35.
 Proliferous Ferns, 192.
 Prosenchyma, 14. 16.
 Proximate principles, 21. 215.
 Pulp, 7.
 Putamen, 426.
 Quartine, 413.
 Quintine, 413.
 Rachis, 240.
 Raceme, 256.

- Radicle, 505.
 Rafflesia, 324.
 Ranunculus, 312. 365.
 Raphe, 405. 488.
 Receptacle, 263. 300. 337. *b*.
 Regular leaf-buds, 146.
 Replum, 449.
 Reseda, 473.
 Reservoirs of oil, 35.
 Rhizoma, 131.
 Rhododendron, 440.
 Rhubarb, 187.
 Ricinus, 478.
 Root, 63.
 Rose, 313. 321. 337. 365.
 368.
 Ruminated, 497.
 Sac of the embryo, 415.
 Safröhren, 29.
 Sarcocarp, 426.
 Saururus, 501.
 Scales, 236.
 Scaly root, 134.
 Scutellum, 541.
 Secretions, 198.
 Secundine, 399.
 Seeds, 54. 56. 469.
 Sepals, 290.
 Septicidal, 433.
 Seta, 535.
 Sexes, 227.
 Shields, 541.
 Silicula, 459.
 Siliqua, 458.
 Simple, 273.
 Simple fruit, 442.
 Sleep of plants, 204 *c*.
 Solitary, 254, 255.
 Sori, 529.
 Spadix, 259.
 Spathe, 232.
 Spermoderm, 485.
 Spike, 257.
 Spine, 139.
 Spiral vessels, 23.
 Spiralgefäße, 23.
 Spongelets, 66.
 Sporules, 529.
 Spurious dissepiments, 384.
 Stamens 302.
 Strawberry, 443. 452.
 Stem, 67.
 Stigma, 345.
 Stipules, 183.
 Stomates, 44.
 Strophiolæ, 477.
 Style, 346.
 Sugar, 214.
 Superior calyx, 391.
 Superior ovary, 392.
 Suspended, 372.
 Syncarpous, 355. *a*.
 Syngenesious, 326.
 Tela cellulosa, 7.
 Tendril, 170. 276.
 Tercine, 413.
 Terminal, 252. 254.
 Testa, 412. 485.
 Tetratheca, 324.
 Thecæ, 529.
 Thecaphore, 355.
 Thespesia, 386.
 Thuja, 466.
 Thyrsus, 266.
 Tigelle, 507.
 Tissu cellulaire, 7.
 cellulaire allongé, 19.
 Tissue, vasiform, 18. *a*.
 vascular, 23.
 Torus, 300.
 Trachées, 23.
 Tube, 287.
 Tuber, 131.
 Umbel, 261.
 Umbilicus, 479.
 Umbelliferæ, 314. 439.
 Unguiculate, 295.
 Unguis, 295.
 Unsymmetrical flower,
 293. *a*.
 Utricle, 454.
 Valves of fruit, 431.
 Vasa fibrosa, 19.
 Vasa spiralia, 23.
 Vasculares, 28.
 Ventral suture, 430.
 Vessels of the latex,
 35.
 Vernation, 191.
 Vine, 276.
 Vitellus, 501.
 Vrille, 170.
 Walnut-tree, 36.
 Water-plants, 36.
 Wheat, 497.
 Wood, 90.
 Woody tissue, 19.
 Zellgewebe, 7.

II.

INDEX OF THE PRINCIPAL NATURAL ORDERS.

WITH SOME OF THE MORE IMPORTANT SYNONYMES.

N.B. The Numbers are those of the Orders themselves.

- | | | |
|---|--------------------------------------|---|
| ABETINÆ <i>Endl.</i> = Con-
cæ. | Alsineæ , 95. | Apostasiacæ , 272. |
| Acanthacæ , 212. | Aloineæ = Asphodeleæ . | Aquifoliacæ , 173. |
| Aceracæ , 60. | Amarantacæ , 155. | Aquilariacæ , 147. |
| Acoracæ , 247. | Amaryllacæ , 237. | Aracæ , 246. |
| Ægiceræ , 170. § | Ampelidæ = Vitacæ . | Araliacæ , 12. |
| Æsculacæ , 62. | Amygdalæ , 109. | Aristolochiacæ , 154. |
| Alangiaceæ , 24. | Amyridacæ , 118. | Artocarpeæ , 124. § |
| Algacæ , 293. | Anacardiaceæ , 119. | Asarinæ = Aristolochiacæ |
| Algæ = Algacæ . | Andreaceæ , 287. | Asclepiacæ , 217. |
| Alismacæ , 267. | Anonacæ , 9. | Asperifoliaæ = Boraginacæ |
| | Apocynacæ , 216. | Asphodeleæ , 264. § |

- Asteraceæ, 193.
 Atherospermaceæ, 140.
 Aurantiaceæ, 80.
 Balanophoraceæ, 276.
 Balsaminaceæ, 104.
 Balsamaceæ, 138.
 Baueraceæ, 114.
 Begoniaceæ, 39.
 ?? Belvisiæ, 181.
 Berberaceæ, 16.
 Betulaceæ, 121.
 Bignoniaceæ, 206.
 Bixaceæ, 54.
 Boraginaceæ, 222.
 Brexiaceæ, 163.
 Bromeliaceæ, 242.
 Bruniaceæ, 15.
 Brunoniaceæ, 197.
 Burmanniaceæ, 239.
 Bursaceæ, 86.
 Butomaceæ, 266.
 Cactaceæ, 36.
 Cæsalpiniaceæ, § 110.
 Callitrichaceæ, 142.
 Calycanthaceæ, 113.
 Calyceraceæ, 190.
 Campanulaceæ, 180.
 Cannæ = Marantaceæ.
 Capparidaceæ, 41.
 Caprifoliaceæ, 188.
 Caryophyllæ = Silenaceæ
 and Alsiniaceæ.
 Casuaraceæ, 129.
 Cassythaceæ, 151.
 Cedrelaceæ, 78.
 Celastraceæ, 90.
 Cephalotaceæ, 5.
 Ceratophyllæ, § 124.
 Cestraceæ, 227.
 Chaillotiaceæ, 83.
 Characeæ, 290.
 Chenopodiaceæ, 156.
 Chlenaceæ, 68.
 Chloranthaceæ, 133.
 Chrysobalanaceæ, 112.
 Cichoraceæ, 192.
 Cinchonaceæ, 186.
 Circææ, 22. §
 Cistaceæ, 69.
 Columelliaceæ, 182.
 Combretaceæ, 23.
 Commelinaceæ, 265.
 Compositæ = Asteraceæ,
 &c.
 Conaceæ, 232.
 Coniferæ = Conaceæ.
 Connaraceæ, 111.
 Convolvulaceæ, 176.
 Cordiaceæ, 224.
 Coriaceæ, 106.
 Cornaceæ, 32.
 Crassulaceæ, 117.
 Cruciaceæ, 40.
 Cruciferae = Cruciaceæ.
 Cucurbitaceæ, 34.
 Cunoniaceæ, 115.
 Cupulaceæ, 120.
 Cuscutaceæ, 175.
 Cyatheaceæ, *Endl.*, 278. §
 Cycadaceæ, 231.
 Cyclanthaceæ, 244.
 Cynomoriaceæ, 277.
 Cynaraceæ, 194.
 Cyperaceæ, 256.
 Cyripediaceæ, 273.
 Cyrtandraceæ, 208.
 Cytinaceæ, 275.
 Danæaceæ, 281.
 Datisaceæ, 131.
 Desvauxiaceæ, 257.
 Dilleniaceæ, 10.
 ? Dionææ, 5-6.
 Dioscoreaceæ, 249.
 Diosmeæ, 100. §
 Dipsaceæ, 195.
 Dipteraceæ, 74.
 Droseraceæ, 46.
 Ebenaceæ, 172.
 Ehretiaceæ, 223.
 Elæagnaceæ, 144.
 Elæocarpaceæ, 73.
 Elatinaceæ, 65.
 Empetraceæ, 126.
 Epacridaceæ, 168.
 Equisetaceæ, 230. .
 Ericaceæ, 166.
 Eriocaulonæ, 258.
 Erythroxyleæ, 92. §
 Escalloniaceæ, 14.
 Euphorbiaceæ, 87.
 Ficoidaceæ, 38.
 Flacourtiaceæ, 50.
 Fluvaceæ, 252.
 Fouquieraceæ, 89.
 Francoaceæ, 20.
 Frankeniaceæ, 47.
 Fumariaceæ, 28. §
 Fungaceæ, 291.
 Galacinæ = Francoaceæ.
 Garryaceæ, 122.
 Gentianaceæ, 214.
 Geraniaceæ, 103.
 Gesneraceæ, 211.
 Gilliesiaceæ, 263.
 Gleicheniaceæ, 279.
 Globulariaceæ, 199.
 Gnetaceæ, 228.
 Goodeniaceæ, 184.
 Graminaceæ, 255.
 Grossulaceæ, 13.
 Guttaceæ, 55.
 Guttiferae = Guttaceæ.
 Hæmodoraceæ, 238.
 Halorageæ, 22. §
 Hamameliaceæ, 31.
 Heliotropiæ, 223. §
 Hensloviaceæ, 123.
 Hepataceæ, 289.
 Hernandiaceæ, 146.
 Hippocrateæ, 90. §
 Hippocastanæ = Æscula-
 cææ.
 Homalinaceæ, 37.
 Hugoniaceæ, 67.
 Humiriaceæ, 79.
 Hydrocereæ, 104. §
 Hydrocharaceæ, 243.
 Hydroleaceæ, 178.
 Hydropeltideæ, 3. §
 Hydrophyllaceæ, 225.
 Hymenophylleæ, 279. §
 Hypericaceæ, 58.
 Hypoxidaceæ, 236.
 Ilicinæ = Aquifoliaceæ.
 Illecebraceæ, 97.
 Illigeraceæ, 150.
 Iridaceæ, 241.
 Jasminaceæ, 219.
 Juglandaceæ, 128.
 Juncaginaceæ, 253.
 Juncaceæ, 268.
 Jungermanniaceæ, 288.
 Labiaceæ, 201.
 Labiateæ = Labiaceæ.
 Lacistemaceæ, 132.
 Lauraceæ, 149.
 Lecythaceæ, 29.
 Leguminaceæ, 110.
 Lentibulaceæ, 213.
 Lichenaceæ, 292.
 Liliaceæ, 264.
 Limnanthaceæ, 108.
 Linaceæ, 66.
 Loasaceæ, 35.
 Lobeliaceæ, 179.
 Loganiaceæ, 220.
 Loranthaceæ, 33.
 Lycopodiaceæ, 283.
 Lygodysodeaceæ, 187.
 Lythraceæ, 76.
 Magnoliaceæ, 7.
 Marattiaceæ = Danæaceæ.
 Melanthaceæ, 262.
 Melastomaceæ, 27.
 Malesherbiaceæ, 52.
 Malpighiaceæ, 92.
 Malvaceæ, 72.
 Marantaceæ, 234.
 Marcgraviaceæ, 57.
 Marsileaceæ, 284.
 Meliaceæ, 77.
 Memecylaceæ, 26.
 Menispermaceæ, 162.

- Millingtoniaceæ, 61. §
 Mimoseæ, 110. §
 Monimiaceæ, 139.
 Monotropaceæ, 165.
 Moreæ, 124. §
 Moringaceæ, 45.
 Musaceæ, 235.
 Mutisiaceæ, 191.
 Muscaceæ, 286.
 Myoporaceæ, 203.
 Myricaceæ, 127.
 Myristicaceæ, 6.
 Myrsinaceæ, 170.
 Myrtaceæ, 28.
 Nandineæ, 16. §
 Nelumbiaceæ, 4.
 Nepenthaceæ, 153.
 Nitrariaceæ, 85.
 Nolanaceæ, 174.
 Nyctaginaceæ, 161.
 Nymphiaceæ, 3.
 Ochnaceæ, 98.
 Olacaceæ, 19.
 Oleaceæ, 218.
 Onagraceæ, 22.
 Ophioglosseæ, 282.
 Orchidaceæ, 270.
 Orobanchaceæ, 210.
 Osmundaceæ, 280.
 Oxalidaceæ, 105.
 Palmaceæ, 260.
 Pandanaceæ, 245.
 Pangiacæ, 51.
 Papaveraceæ, 2.
 Papayaceæ, 49.
 Parkeriaceæ, 279. §
 Passifloraceæ, 48.
 Pedaliaceæ, 207.
 Penæaceæ, 152.
 Petiveriaceæ, 159.
 Philadelphaceæ, 30.
 Philydraceæ, 269.
 Phytolaccaceæ, 157.
 Pistiaceæ, 254.
 Piperaceæ, 135.
 Pittosporaceæ, 18.
 Plantaginaceæ, 198.
 Platanaceæ, 137.
 Plumbaginaceæ, 200.
 Podophylleæ, 1. §
 Podostemaceæ, 141.
 Polemoniaceæ, 177.
 Polygalaceæ, 63.
 Polygonaceæ, 158.
 Polypodiaceæ, 278.
 Pomeæ, 109. §
 Pontederaceæ, 261.
 Portulacæ, 93.
 Potaliaceæ, 221.
 Primulaceæ, 169.
 Proteaceæ, 148.
 Pyrolaceæ, 164.
 Rafflesiaceæ, 274.
 Ranunculaceæ, 1.
 Reaumuriaceæ, 70.
 Resedaceæ, 42.
 Restiaceæ, 258.
 Rhamnaceæ, 82.
 Rhizobolaceæ, 56.
 Rhizophoraceæ, 25.
 Rosaceæ, 109.
 Roxburghiaceæ, 251.
 Rutaceæ, 100.
 Salicaceæ, 136.
 Salicariæ = Lythraceæ.
 Salviniaceæ, 285.
 Samydaceæ, 44.
 Sanguisorbeæ, 109. §
 Santalaceæ, 143.
 Sapindaceæ, 61.
 Sapotaceæ, 171.
 Sarraceniaceæ, 21.
 Saururaceæ, 134.
 Saxifragaceæ, 116.
 Scævolaçæ, 185.
 Schizandreæ, 9. §
 Scitamineæ = Zingibera-
 cææ.
 Scleranthaceæ, 160.
 Scrophulariaceæ, 209.
 Selaginaceæ, 204.
 Silenaceæ, 94.
 Simarubaceæ, 99.
 Smilaceæ, 250.
 Solanaceæ, 226.
 Spigeliaceæ, 215.
 Spondiaceæ, 81.
 Stackhouseaceæ, 88.
 Staphyleaceæ, 91.
 Stellaceæ, 189.
 Sterculiaceæ, 71.
 Stilaginaceæ, 125.
 Stilbaceæ, 205.
 Styliidiaceæ, 183.
 Sytracæ, 172. §
 Surianaceæ, 107.
 Swartzieæ, 110. §
 Taccaceæ, 240.
 Tamaricaceæ, 96.
 Taxaceæ, 229.
 Terebintaceæ = Amyrida-
 cææ, &c.
 Ternströmiaceæ, 59.
 Thymelaceæ, 145.
 Tiliaceæ, 75.
 Tremandraceæ, 84.
 Tropæoleæ, 104. §
 Turneraceæ, 53.
 Typhaceæ, 248.
 Ulmaceæ, 130.
 Umbelliferæ = Umbella-
 cææ.
 Urticaceæ, 124.
 Vacciniaceæ, 167.
 Valerianaceæ, 196.
 Vanillaceæ, 271.
 Verbenaceæ, 202.
 Violaceæ, 43.
 Vitaceæ, 17.
 Vites = Vitaceæ.
 Viticeæ = Verbenaceæ.
 Vochyaceæ, 64.
 Winteraceæ, 8.
 Xanthoxylaceæ, 102.
 Xyridaceæ, 259.
 Zingiberaceæ, 233.
 Zygophyllaceæ, 101.

THE END.

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